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## EXPRESS STEAMSHIP KRONPRINZ WILHELM.

In the latter part of September there arrived in this port the steamship *Kronprinz Wilhelm*, the latest addition to the German fleet of transatlantic liners. This new competitor for the "Blue Ribbon of the Atlantic," belongs to the North German Lloyd Steamship Company and was built by the Vulcan Shipbuilding Company of Stettin, Germany. She is the third high speed liner turned out by this shipyard, and in many respects resembles the other two, i. e., the *Kaiser Wilhelm der Grosse*, belonging to the same company, and the *Deutschland*, of the Hamburg-American Line. She is 15 feet longer than the former, and 21 feet shorter than the latter. The cost, with all equipment, ready for service, is approximately $3,200,000, an increase of $500,000 over the *Kaiser Wilhelm der Grosse*, and it is interesting to note that the German companies have found that the increased first cost and operating expenses of these flyers have, nevertheless, made them dividend producing investments, as on all of their passages they have carried almost as many as the accommodations would allow.

NEW TWIN-SCREW EXPRESS STEAMSHIP KRONPRINZ WILHELM.

The general dimensions of the *Kronprinz Wilhelm* are as follows:

| | |
|---|---|
| Length over all | 663 feet. |
| Beam | 66 " |
| Depth, moulded | 43 " |
| Gross tonnage | 15,000 tons. |
| Draught (normal) | 28 ft. 6 in. |
| Corresponding displacement | 21,300 tons. |

This displacement includes 4,400 tons of coal and 5,250 tons of cargo.

The *Kronprinz Wilhelm* was built to the highest class of the German Lloyds as a four decker with considerable extra stiffening. Several flying decks are fitted for passenger and boat accommodation. The poop is 115 feet long, the bridge house 374 feet, and the forecastle 115 feet. Above the poop and bridge house there is a promenade deck 508 feet long, and above this a sun deck of equal length. A double water bottom extends nearly the entire length of the steamer, and is divided into 24 water tight compartments, while the interior of the ship is divided by 15 transverse bulkheads reaching to the upper deck. All bulkheads have been made sufficiently strong to stand the pressure due to anyone of the compartments being filled while the adjoining compartments are empty.

The motive power consists of two 6-cylinder 4-crank quadruple expansion engines of 33,000 indicated horse power, built on the Schlick balance system. The diameters of the cylinders are 34.2 inches high pressure, 68.8 inches first intermediate, 98.4 inches second intermediate, and 102.3 inches low pressure, all having a common stroke of 78.8 inches. The high pressure cylinders are placed above the two low pressure cylinders, and these two pairs are at the middle; the first intermediate cylinder being at the forward end of the engine, and the second intermediate at the after end. The normal speed of the engine is 80 revolutions per minute, although 84 can easily be obtained. With the exception of the valve mechanism of the high pressure cylinders, the engines of the *Kronprinz Wilhelm* are identical with those of the *Deutschland*, which are fully described and illustrated in MARINE ENGINEERING for June and July of the present year.

Steam is supplied at 213 pounds pressure by 16

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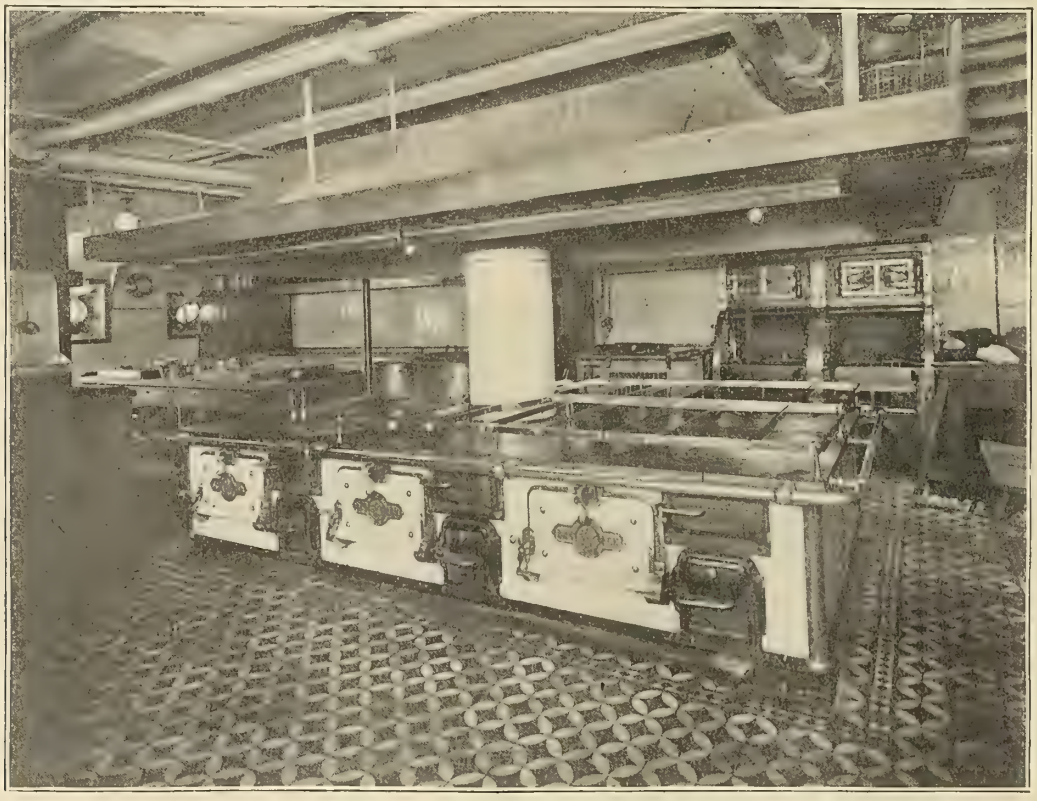
Scotch boilers, of which 12 are double end and 4 are single end. All are 16 feet 9 inches in diameter, and the double end boilers are 20 feet 8 inches long and of 104 tons weight each. The total number of furnaces, 45 inches in diameter, is 112, giving a total grate surface of 2,702 square feet. The total heating surface is 93,865 square feet. The boilers are to be worked under natural draught and are arranged in four batteries, each with a funnel whose height above grate bars is 110 feet, the diameter being 14 feet 9 inches. Coal is stored in wing bunkers extending the full length of the boiler compartment, and in a large 'thwartship bunker between the second and third boiler rooms.

The shafting is made of Siemens-Martin steel, and the diameters of the various lengths are: crank shaft, 24 inches; thrust shaft, 23.6 inches; tunnel shaft, 22.8 inches; propeller shaft, 24.8 inches.

The propellers are manganese bronze, each with four blades, 21 feet 10 inches in diameter, and 32 feet 9 inches pitch. To enable the propeller shaft to be withdrawn from the outside of the hull, a large flat coupling has been fitted to the propeller shaft, the weight of coupling being about 11 tons. All pumps are separated from the main engine, and the two independent condensers have a combined cooling surface of 20,560 square feet, while the two auxiliary condensers have 646 square feet of surface. The air pumps, feed pumps and heaters are made by Messrs. Weir and Cathcart. Other auxiliary machinery includes a full equipment of bilge and fire pumps capable of handling 3,600 tons of water per hour; 4 electric generating sets, and 2 Lind's refrigerating machines. A duplicate steam steering gear is located in the poop in case of mishap to the main gear, which is of the Brown type.

The windlasses and capstans are built by Napier Brothers, and are of extra heavy dimensions.

The accommodations for the first cabin passengers are placed amidships on the main, upper and promenade decks, and are provided with every possible comfort for the traveling public. Four cabines de luxe, composed of sitting room, bedrooms and bathroom, and eight suites consisting of bedroom and bathroom, have been furnished for the accommodation of those who wish to travel in luxury. There are also staterooms on the awning or bridge deck.



GALLEY OF THE KRONPRINZ WILHELM.

The first cabin dining room has 414 seats, and is beautifully decorated with allegorical paintings on the ceiling, and green and bronze panelled walls. Adjoining the main dining room, there are forward and aft, on each side, extensions forming, as it were, small dining rooms; these are also beautifully decorated with landscape paintings. The large central skylight and handsomely glazed and arched cupola transmit abundant light. The vestibule on the promenade deck joins into the social hall above the dining room, where is placed a life-sized portrait of the German Kronprinz Wilhelm. The hall is provided with comfortable furnishings, handsome tapestries, and many pictures of Prussian cities.

In the library, which is decorated in Renaissance, are a number of writing desks, and well filled book-

LIBRARY.

MUSIC ROOM OF THE KRONPRINZ WILHELM, OF THE NORTH GERMAN LLOYD STEAMSHIP CO.

cases. The smoking room is also in Renaissance with panelled oak ceiling and walls.

The steward's department has been arranged with great care and furnished with modern equipment.

The total number of passengers carried is 1,651, including 650 first and 350 second class passengers, while the crew number 520, including 69 deck hands, 241 in the engine room staff, 51 in the kitchen department, with 150 stewards and 4 postal officials.

In the equipment of the ship many innovations have been introduced to provide for the comfort and convenience of the passengers. A telephone system, extending from the public rooms, official departments, wine cellars, and many private rooms, has been installed, and provision made at the central office so that the system may be coupled to any land trunk line when in port. The ship is also equipped with the Marconi wireless telegraph system. Messenger boy service is supplied to all parts of the ship.

The importance of keeping the water tight bulkheads intact has been recognized by placing doors in those bulkheads only which are in the machinery section, and these doors are electrically controlled from the bridge and other positions of the ship. Fire alarms are placed at various points, and the fire signal may be sent out and the pumps started working from any one of these stations.

On the *Kronprinz Wilhelm's* maiden passage from New York to Plymouth, she averaged for the entire run 23.01 knots, which eclipses all records for maiden voyages. The distance was covered in 5 days 9 hours, 48 minutes, and the greatest single day's run was 540 miles.

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**Return of the Concord.**—After an absence of fou years the United States Steamship *Concord*, Commander G. Blocklinger, arrived at San Francisco, Cal., Sept. 28.

**Engineers' Wages Raised.**—The Marine Engineers' Beneficial Association No. 33, of New York, have issued a circular to the various lines of steamships running out of New York under the United States flag, giving the schedule of wages to be paid and the number of assistant engineers to be employed. For the foreign trade, which takes in Central America, South America and the West Indies, the vessels are divided into two classes. The first class comprises vessels of 2,500 tons gross and over and all vessels bound to Pacific ports. The wages for this class are: Chief, $150; first assistant, $90; second assistant, $80; third assistant, $70 per month. Second class takes in steamers of 1,200 tons and under 2,500 tons. The rate of wages for this class is: Chief, $135; first assistant, $80; second assistant, $70; third assistant, $60 per month. All steamers in the above classes are compelled to carry three assistant engineers. The coastwise trade is comprised of two classes, vessels of 2,500 tons gross and over being in the first class, and those of from 1.200 to 2,500 tons gross forming the second class. The rate of wages for each class is the same as above given. All steamers on a run exceeding twenty-four hours will carry three assistant engineers, and those on a run of less than twenty-four hours to have two assistant engineers.

## CAUSES OF BREAKAGE OF PROPELLER SHAFTS.

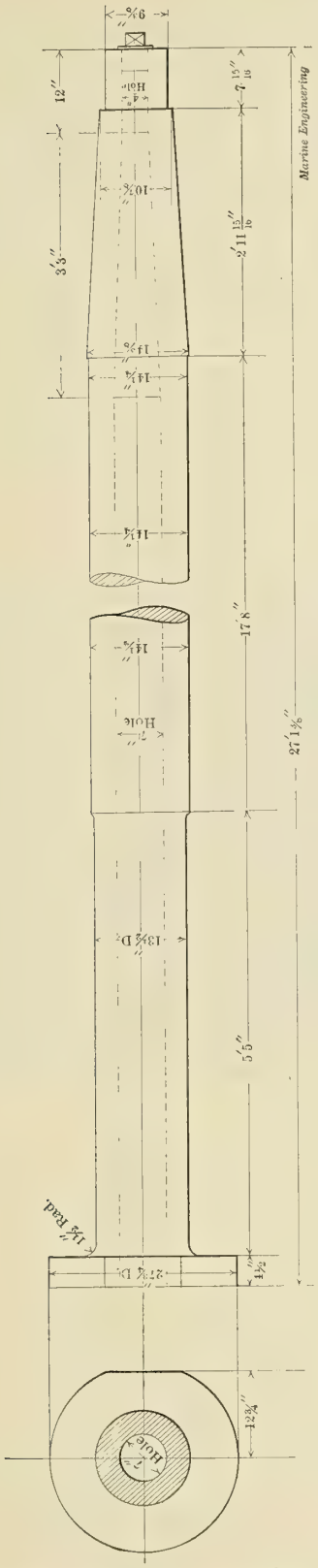
An examination into the causes of machinery breakdowns on steamers makes a most interesting starting point for the marine engineer in designing new work. If, from an examination of these records covering the different seasons of the year, he finds that any appreciable percentage of the breakdowns pertained to one particular part of the machinery, his attention should be drawn to that part to strengthen and improve its design so that, like the one-horse shay, his future productions would run until each and every part was worn out. Such an ideal design is of course impossible, owing to the unforeseen and unknown strains that are met with, but that condition can surely be more nearly reached in some particulars than it is at present.

One of the parts most frequent to give out in a marine engine is the shafting. During the last six months the total number of machinery breakdowns reported by British Lloyds was 374, and of these 83, or 22 per cent, were breaks in the shafting. Half of these failures were in the tail shaft, resulting in many instances in a total loss of the broken end and of the propeller. From information obtained in this and other directions it appears to Marine Engineering that a general discussion of this subject by the shipbuilders and owners would result favorably to all parties concerned, as methods of construction, either in improved design or proportion of parts, might be adopted that would decrease the number of breakdowns with their attendant long and costly delays, thereby cutting down the expenses of repairs, thus reducing insurance and eventually lowering freight rates.

While the causes of failures may all be included under the general heading of insufficient strength or too small dimensions, they may be separated under three headings, namely, poor material, unforeseen straining and corrosion.

1st, *Poor Material.* It is the growing practice in this country in large work to use hydraulic forged fluid compressed steel, although hammered iron is still used extensively. The quality of forged iron now attainable is always more or less of an uncertainty, owing to the fact that scrap bought in the open market is of a miscellaneous character, and if any steel scrap is mixed with it perfect welding cannot be assured. Flaws increase in size the longer the part is in service, until finally the section is so weakened that it cannot withstand the load and breaks. The best practice in this country and abroad is to use hollow steel forgings where the central core of the shaft, which generally contains impurities, is removed and the forging thereby lightened with but slight reduction of strength. Internal defects, such as segregation, piping, etc., occur in this central core, and the life of the forging may be increased by their removal.

2d, *Unforeseen Straining.* In addition to the torsional strain on a line of marine engine shafting, which can readily be calculated by adding the turning movements about the center line, there are many unusual strains that are not met with in shafting ashore. The motion of the ship is produced by the thrust of the propeller, and as this thrust is taken up near the en-




FORGED STEEL PROPELLER SHAFT BEFORE CORROSION SET IN.

gine the entire line of shafting is under a compressive stress due to this thrust, and equal approximately to two-thirds the I. H. P. reduced to foot pounds and divided by the speed in feet per minute. As the propeller is overhung there is an additional compression on the lower fibers of the shafting, while the upper fibers are under tension, both strains being greatest at the stern bearing. However, this is not a fixed, but a vibrating load for any and all points on the tail shaft, changing from maximum tension to maximum compression in one revolution, and the effect of such a vibrating load is well known to be much more severe than for a steady load of the same amount. With the a vibrating load is well known to be much more severe running smoothly, the shafting is thus subject to a compound stress, the resultant of the torsion and the combined compression and tension. But when the wheel is only partly under water, as is the case when the vessel is light and tossing around in a heavy sea with the wheel almost entirely out of water one moment and submerged the next, the strain upon the shafting is very great and cannot be calculated. The best guide to proper proportions under these circumstances is experience. When the propeller is partially immersed the bending moment is increased, due to the difference in the thrust of the blades while sweeping through the lower half of their path in solid water and the thrust while passing through the upper half in water and air. The severe pounding when the blades strike the water as the stern descends from the crest of a big wave is enough to rack any machine, and the only wonder is that more shafts are not broken by it. Another unknown strain on the shafting results from the vibration of the engine and the tossing of the ship in a seaway. The vibrations of the hull at the stern, due in part to the engine and in part to the blades of the propeller passing through a medium of varying resistance, set up unknown strains in the tail shaft.

3d, *Corrosion.* The damaging effect of the galvanic action set up between brass and iron in the presence of salt water has long been recognized by engineers, and yet it is surprising to see how this fact is entirely overlooked in some most important parts of the design such as the stern bearing or condenser. The usual form of stern pipe bearing makes an excellent galvanic cell. Two liners are shrunk and tap riveted on the shaft, one at the after end, the other at the forward end of the stern tube, while the water circulates up to the inboard stuffing box freely about the shaft, which bears on strips of lignum vitae. Should the paint or packing used at the end of the liners to fill crevices between shaft and liner break away, water will percolate through this space and corrosion at once set in, and in a place where it cannot be detected except by drawing the shaft and removing the liner.

There are several modifications of this form of fitting. Sometimes the entire shaft in the stern tube is covered with brass sleeves about 3 feet in length and the joints made tight by recessing one into the other and packing. However this jointing may be done, it is impossible to make it absolutely water tight because of the appreciable twist in the shaft, which tends to loosen the liners from it. The British Corporation recommends fusing the ends of the liners together, but the heat necessary to do this would produce local weakness in the shafting at those points. The most recent practice in foreign yards is to use a single brass liner cast in one piece some 23 feet long and shrunk on the propeller shaft. The difficulty in getting a sound

metal casting is overcome by properly drying the sand in the mould.

An inquiry sent out by a large steel company to eighteen of the prominent shipbuilders in the country, concerning the methods of securing liners to shafts, elicited the following facts: Two stated that their practice was to secure the liner simply by shrinking it on; two either shrunk the liner on or used tap rivets to secure it more permanently, and fourteen used tap rivets in addition to shrinking; four believed that the reduction of cross section by using the tap rivets did not weaken the shaft; nine thought that it did weaken it somewhat, and five gave no opinion.

In England linerless shafts are growing in favor among many superintendents. One of the steamship companies has used none but these for many years, and the shafts are in as good apparent condition today as ever. The method of protecting them from corrosion is to put a gland at the stern bush and fill the tube with oil. A modification of this, where tallow is used for a lubricant instead of oil, was given in MARINE ENGINEERING for October. In these cases the 'bushings are made of cast iron or white metal.

The diameter of the shafting has recently been increased by the British Corporation, whose formula now is:—

$$D = \sqrt[3]{\frac{P L^2 S}{C}} \times B$$

Where D = diameter of shaft in inches.
P = absolute steam pressure.
L = diameter low pressure cylinder.
S = stroke in inches.
C = constant depending on ratio of the square of the low pressure to the square of the high pressure cylinder.
B = a constant whose value is 1.0 for crank and thrust shafts, .95 for intermediate shafts, and for tail shafts it depends on the ratio of the diameter of the propeller to diameter of crank shaft, and on the coefficient of displacement at 4-5 moulded depth.

Lloyd's Register also increased their rules for shafting two years ago, and for a three-crank triple expansion engine the diameter of the intermediate is found by the following formula:—

$$T = (.038A + .009B + .002D + .0165S) \times \sqrt[3]{P}$$

Where A = diameter of high pressure cylinder in inches.
B = diameter of intermediate cylinder in inches.
D = diameter of low pressure cylinder in inches.
S = stroke of piston in inches.
P = boiler pressure above atmosphere.

The diameter of the tail shaft is to be equal to the diameter of the intermediate shaft multiplied by $(.3 + \frac{.03 P}{T})$ but in no case to be less than 1.07 T.

Where P = diameter of propeller in inches.

The formula for T varies, depending upon the number of cylinders and number of cranks.

Both of these figure out nearly the same as those laid down by the American Bureau of Shipping some twelve years ago, which are:—

$$T = \sqrt[3]{\frac{P S D^2}{C}}$$

Where T = diameter of shaft.
P = absolute steam pressure.
S = stroke in inches.
D = diameter of low-pressure cylinder.
C = constant, according to the following table:

| | For crank and propeller shafts. | For intermediate shafts. |
|---|---|---|
| Double Expansion | 10,000 | 12,000 |
| Triple " | 18,000 | 20,000 |
| Quadruple " | 20,000 | 22,000 |

Comparing results obtained by the use of the rules of the three societies we find the size of tail shaft for a triple expansion engine, recently built, with cylinders 28, 45 and 72 inches in diameter, by 54-inch stroke, with steam at 182 pounds absolute, and driving a single screw 16 feet diameter is:

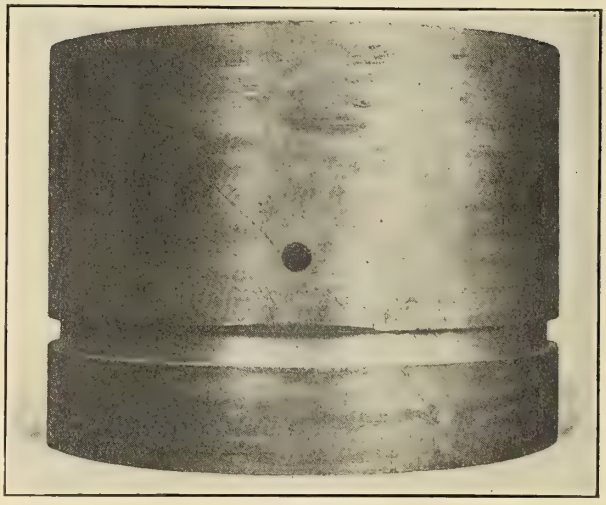


FIG. 1. DIAGONAL CRACK ACROSS TOP OF RIVET HOLE.

British Corporation $\sqrt[3]{\frac{182 \times 72^2 \times 54}{17730}} \times 1.02 = 14.50$

Lloyd's Register $(.038 \times 28 + .009 \times 45 + .002 \times 72 + .0165 \times 54) \times \sqrt[3]{P} = 14.19$. $14.19 \times 1.07 = 15.18$ inches

American Bureau $\sqrt[3]{\frac{182 \times 54 \times 72^2}{18000}} = 14.15$ inches.

The British Corporation and Lloyd's rules take into consideration the size of the wheel, which bears a large factor in determining the bending stress when the propeller is but partially immersed.

The causes for failures are no doubt due to a combination of these three weaknesses—poor material, severe and unforeseen straining, and corrosion; but, no matter how strong the shaft may be in regard to quality or size, nor how well protected from chemical action, unless it is well taken care of it will give out in short order. The rules of the societies now require that shafts be drawn for inspection every two years, yet some companies draw them more frequently.

A remarkable case of corrosion occurred to a new

hollow steel propeller shaft of the sizes given on page 445. Brass liners 3 feet long, shrunk and riveted on, covered the entire length which was within the stern tube. Nine months after the shaft had been fitted the engineer noticed water dripping from the central hole in the after crank shaft and believing it must come from a fissure through the tail shaft, the shaft was drawn and the liners removed, when a diagonal crack was discovered running across one of the tap rivet holes and extending through the walls of the shaft.

Sections of this shaft are shown in Figs. 1, 2, 3 and 4. It was returned to the factory, placed in a lathe and a light cut taken over the surface covered by the liners. Corrosion was found at all of the liner joints but the worst was at the joint of the two end sleeves. At this point a cut was made 3-8 inch wide by 7-8 inch to learn to what depth corrosion had gone. Through the center of the crack through the rivet hole (see Fig. 1) a long cut one inch wide was made by a planer, which showed the crack extended 1 3-4

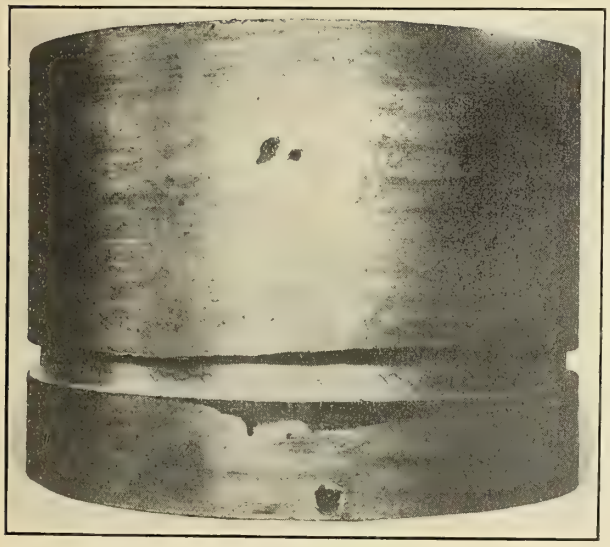


FIG. 2. CORROSION SPOTS ON SURFACE COVERED BY SLEEVES.

inch below the surface. Several other cracks and corroded spots such as those in Figs. 1 and 2 were found along the body of the shaft. Analyses of the material were made both before the shaft left the shop and upon its return. In the latter case the samples were cut from the section, as shown in Fig. 4, and the results for both tests were:

| | Tensional Stress. | Elastic Limit. | Elongation 2 in. specimen. |
|---|---|---|---|
| Before leaving | 70,000 | 36 810 | 28.0% |
| When returned | 71,070 | 35,200 | 29.5% |

These results are practically alike, showing that the metal which was free from corrosion had in no way weakened.

An analysis of the brass sleeves showed the alloy to be as follows:

| | |
|---|---|
| Tin | 9.21% |
| Copper | 86.65% |
| Lead | .08% |
| Zinc | 3.89% |

This high percentage of copper was doubtless one of the reasons for rapid corrosion, as it is found that galvanic action proceeds more slowly when the brass contains only from 45 to 50 per cent copper. The report of the experts who examined this shaft was that the "failure was by detail, hastened by annular nicking, caused by corrosion arising from galvanic action set up by the sleeves."

Those interested in this subject are referred to the papers on Propeller Shafts presented before the In-

FIG. 3. CORROSION AND DIAGONAL CRACKS.

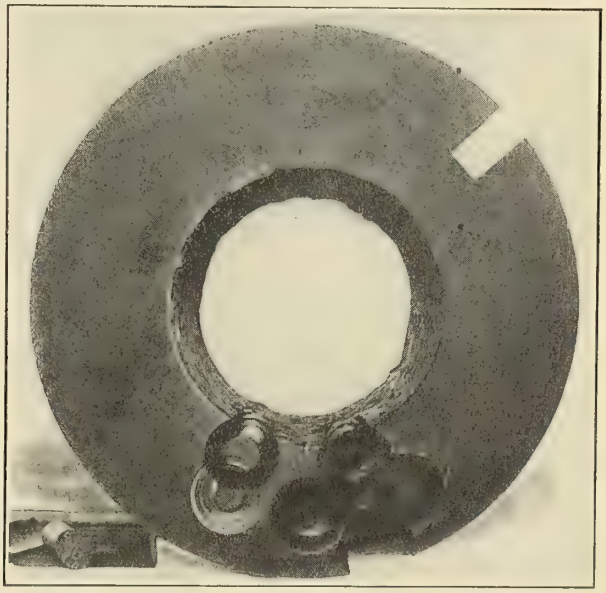
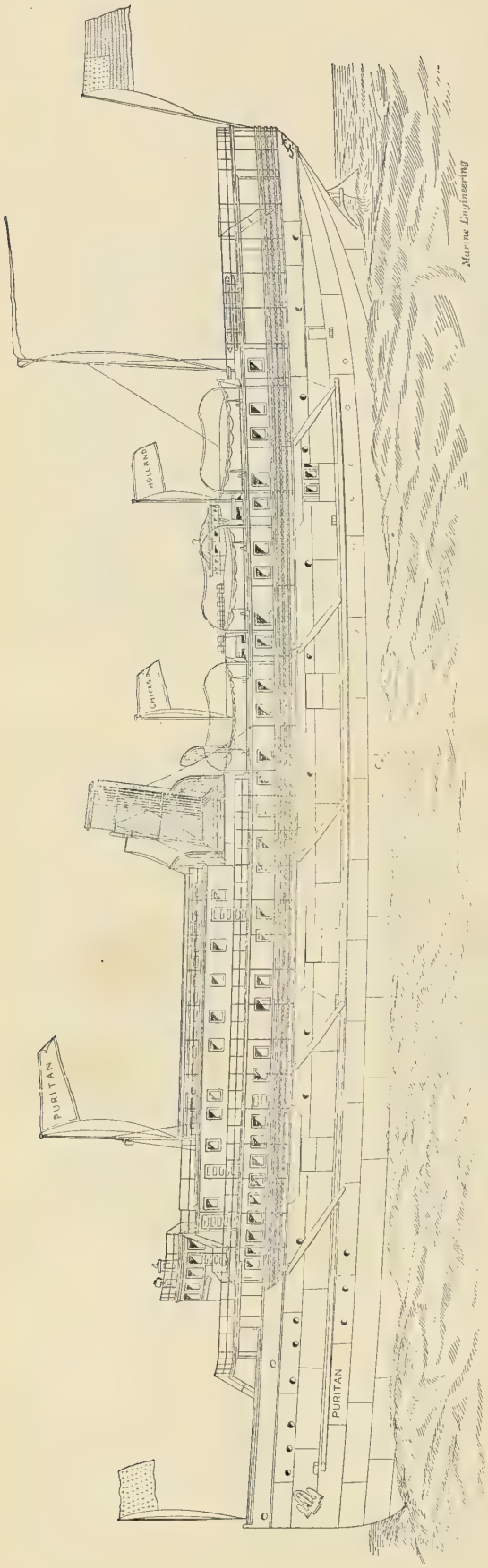


FIG. 4. LOCATION OF TEST SPECIMENS.

stitute of Marine Engineers, by Messrs. E. Nicholl and F. G. Mason on September 24, 1900, which have been fully drawn from in writing this article.

It is the desire of MARINE ENGINEERING that a full discussion of this subject will follow, and all communications will be received with appreciation.

**Naval Estimates.**—The estimates for the Navy for the year ending June 30, 1903, are the largest on record, amounting to $98,910,984, against $77,924,535 appropriated for the current year.




PASSENGER AND FREIGHT STEAMER PURITAN, FOR THE GREAT LAKES

## PASSENGER STEAMER PURITAN.

The latest addition to the passenger service on Lake Michigan is the new steel screw passenger steamer *Puritan*, an outboard profile of which is published herewith, which was recently built for the Graham and Morton Transportation Co., to ply between Holland, Mich., and Chicago. This route is a favorite with Chicago people, and a large excursion business is carried on, in addition to an immense traffic in fruit and package freight, so that the steamers must be constructed to carry a large amount of the latter in addition to meeting the requirements of a first-class passenger boat. That the *Puritan* fulfils all these requirements is attested by her popularity and the business she handles.

The *Puritan* was built by the Craig Ship Building Co., of Toledo, Ohio, and is constructed of open hearth steel of the following dimensions:—

| | |
|---|---|
| Length between perpendiculars | 222 ft. |
| Beam, moulded | 40 " |
| Depth, " | 16 " |
| " to upper deck | 24 " 6 in. |

She was built throughout to meet the requirements of the Bureau Veritas Classification Society, with extra heavy scantlings, thus making her one of the strongest vessels of her class afloat. The following are a few of her principal scantlings:—

The center vertical keel is 48 inches deep by 17 1-2 pounds, fitted with a 36 inch by 17 1-2 pound rider plate on top of the floors with 4 1-2 by 3 inches continuous angles. The frames are 6 inches by 3 inches by 14 pounds, channels spaced 24 inches apart and continuous to upper deck, with web frames of 12 inches by 22 pounds channel, spaced every 24 feet. Solid floors are fitted on every frame, 20 pounds in the machinery space and 18 pounds elsewhere, and are secured to the vertical keel by 3 inches by 4 inches double angles. Deck beams are of channel section, 10 inches by 22 pounds on main deck, and 6 inches by 14 pounds on upper deck, all spaced four feet centers and secured to frames with substantial brackets. Three channel stringers are fitted in the lower hold, one on each side and between decks. The shell plating is as follows:—

Garboard 19 pounds to 16 pounds at ends; bilge and side plating, 17 pounds to 14 pounds at ends; shear strake, 60 inches by 20 pounds, and 17 pounds at ends; between deck plating, 10 pounds. The vessel is constructed with two complete steel decks, and is fitted with three gangways on each side for handling freight. The stern post is a steel casting, and the rudder frame and stem are forgings.

The passenger accomodations are very complete, and all conveniences for a large passenger business are provided. The main cabin on the upper deck is finished in mahogany, and has forty-two staterooms, with the dining room at the forward end. The galley and crew's quarters are directly under the dining room, on the main deck. Aft of the engine room on the main deck is a large smoking room, with connection to the main cabin by a grand stairway, all finished in mahogany, similar to the main cabin. Pilot house and officer's quarters are on the boat deck, on which are also located sixteen staterooms similar to those in the main cabin. The accommodations for second class passengers are under the main deck aft. The steamer has ac-

commodations for 200 first and second class passengers, and is licensed to carry 2,000 excursionists.

The machinery consists of an inverted, direct acting, triple expansion, surface condensing engine, with cylinders 21 inches, 34 inches and 58 inches in diameter, and 40 inch stroke, designed by the Craig Ship Building Co., and built in their own shops. The high pressure and intermediate cylinders are fitted with piston valves, and the low pressure cylinder with a double ported slide valve. All valves are worked by Stephenson double bar link motion, and have adjustable cut-offs, actuated by screws in the arms of the reverse shaft. The reversing gear is direct connected with a steam cylinder 11 inches diameter by 16 inches stroke. All pistons are fitted with cast iron spring rings, the high pressure and intermediate bodies also being cast iron and the low pressure being cast steel. Piston rods

Owing to the large amount of lime in the waters of Lake Michigan, a surface condenser was fitted to obviate any trouble with the scaling of boilers. This condenser is separate from the main engine, and is of the cylindrical type, with steel shell fitted with composition tube sheets and composition tubes tinned inside and out. The cooling surface is 2,500 square feet.

All the pumps are independent of the main engine, and with the exception of the circulating pump, were furnished by Dean Bros., of Indianapolis, Ind. The air pump is of the simplex vertical type, 12 inches by 24 inches by 18 inches; and the main and auxiliary feed pumps are of the Admiralty duplex type, 8 inches by 5 inches by 12 inches. Two duplex pumps, 5 1-2 inches by 5 1-4 inches by 7 inches, and one simplex pump, 4 inches by 4 inches by 5 inches are also fitted for general water service and for pumping from the bilge. Water

STEAMER PURITAN BUILT BY THE CRAIG SHIPBUILDING CO.

are machinery steel, secured to piston by tapered ends and nuts, and to crossheads by cottars. Crossheads are cast steel recessed for crosshead pin boxes and fitted with composition slippers. Connecting rods are wrought iron, the upper end being forked with crosshead pins shrunk in. The crank pin boxes are cast steel lined with best anti-friction metal.

The framing of the engine consists of three cast iron housings of box section in front and back, the latter being fitted with guide surfaces provided with water back for circulation of cooling water. The bedplate is cast iron of box section, cast in one piece, with five main journals.

The lower main journal boxes are cast steel, lined with anti-friction metal, as are also the cast iron caps which form the upper part of the bearings. The crank shaft is of wrought iron, 12 inches in diameter with steel crank pins and cast steel webs. Line and propeller shafting is wrought iron, provided with forged couplings and supported by suitable spring bearings. The thrust bearing is of the horseshoe type, with adjustable shoes. The propeller is four bladed, solid cast iron, 12 feet in diameter and 19 feet pitch.

is circulated through the condenser tubes by a centrifugal pump, with a 10 inch suction and discharge, driven by a 6 inch by 6 inch vertical direct connected engine, supplied by the Morris Machine Works, of Baldwinsville, N. Y.

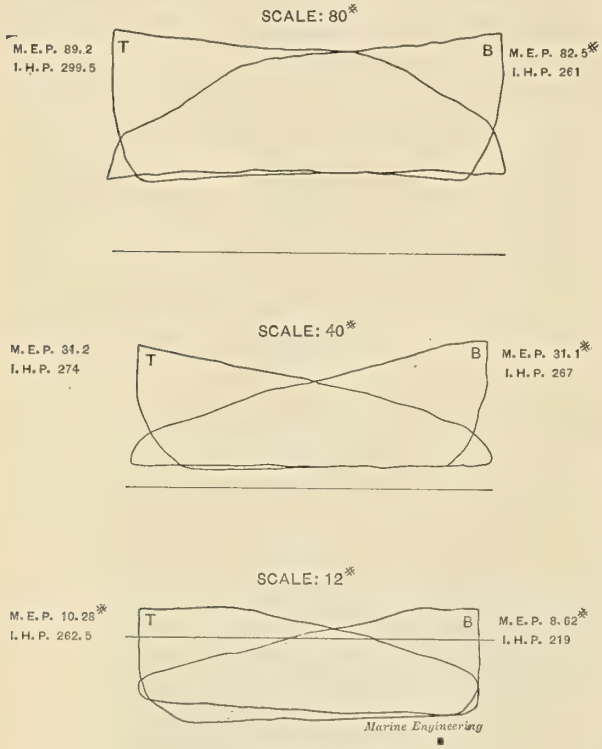
Steam is generated by four water tube boilers with an aggregate heating surface of 7,500 square feet. These boilers were tested to 450 pounds hydrostatic pressure, and are allowed a working pressure of 225 pounds.

The *Puritan* is lighted throughout with electricity, generated by two 15 kilowatt direct connected General Electric Co.'s generators, located in the engine room. She is also fitted with steam steering engine and a Hyde steam windlass. Her anchors are of the Baldt stockless type, and weigh 2,840 pounds each.

Taken altogether the *Puritan* exemplifies the highest class of vessel for the trade in which she is employed, and is a credit to both her owners and builders.

Although she has only been running altogether about six weeks she has already broken the record for the run between St. Joseph, Mich., and Chicago, beating the best time of the whaleback steamer, *Christopher*

*Columbus*, thus ranking her as one of the fastest boats on Lake Michigan. Her time for the run was 3 hours and 11 minutes, making an average of 19 3-4 miles per hour.




INDICATOR CARDS OF THE PURITAN.

The indicator cards herewith were taken on her maiden trip, while on her way to Lake Michigan. They do not, however, show her maximum power, the revolutions being only 96 and the steam pressure 180 pounds, while she now averages 108 revolutions with 200 pounds of steam.

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**Seven-Masted Schooner.** — The scantlings of the seven-masted schooner described in MARINE ENGINEERING of October were increased in some members to meet the requirements of the American Bureau of Shipping in which society the vessel is classed. The bottom plating was increased five pounds per square foot and two longitudinal stringers were added to be worked intercostally between the frames all fore and aft on both upper and lower between decks.

**Wireless Telegraphy.**— The advantages and disadvantages of the Marconi system of wireless telegraphy were demonstrated in the recent maneuvers of the British navy. Messages were transmitted in cypher between ships over 80 miles apart. However these messages were intercepted and read by all the vessels equipped with the Marconi instruments, within that radius. The French squadron intercepted many of these messages, and as a simple code had been used, easily deciphered them. The inventor is devoting his energies to remedying this great defect, and has announced that he is able to obviate these leakages.

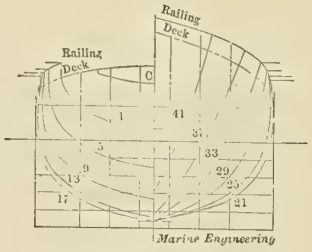
## DESIGN OF GERMAN POLICE LAUNCH BUILT AT THE HOWALDTSWERKE, KIEL, GERMANY.

BY GEORGE CROUSE COOK.

The plans of the high powered steam launch herewith published were prepared by the author while a draughtsman with the Howaldtswerke of Kiel, Germany.

The qualities required in a launch for the special service of the Imperial Police in and about Kiel Bay were handiness, speed, appearance and convenience; and this design, developed on the elemental principles drawn from these requirements, was submitted and accepted as giving due consideration to each of these items. The dimensions chosen were: Length over deck, 74.65 feet; length between perpendiculars, 65.6 feet; moulded beam 10.7 feet; moulded depth, 5.9 feet; maximum draft (at stern), 5.2 feet, with a load displacement on these dimensions of 30 tons.

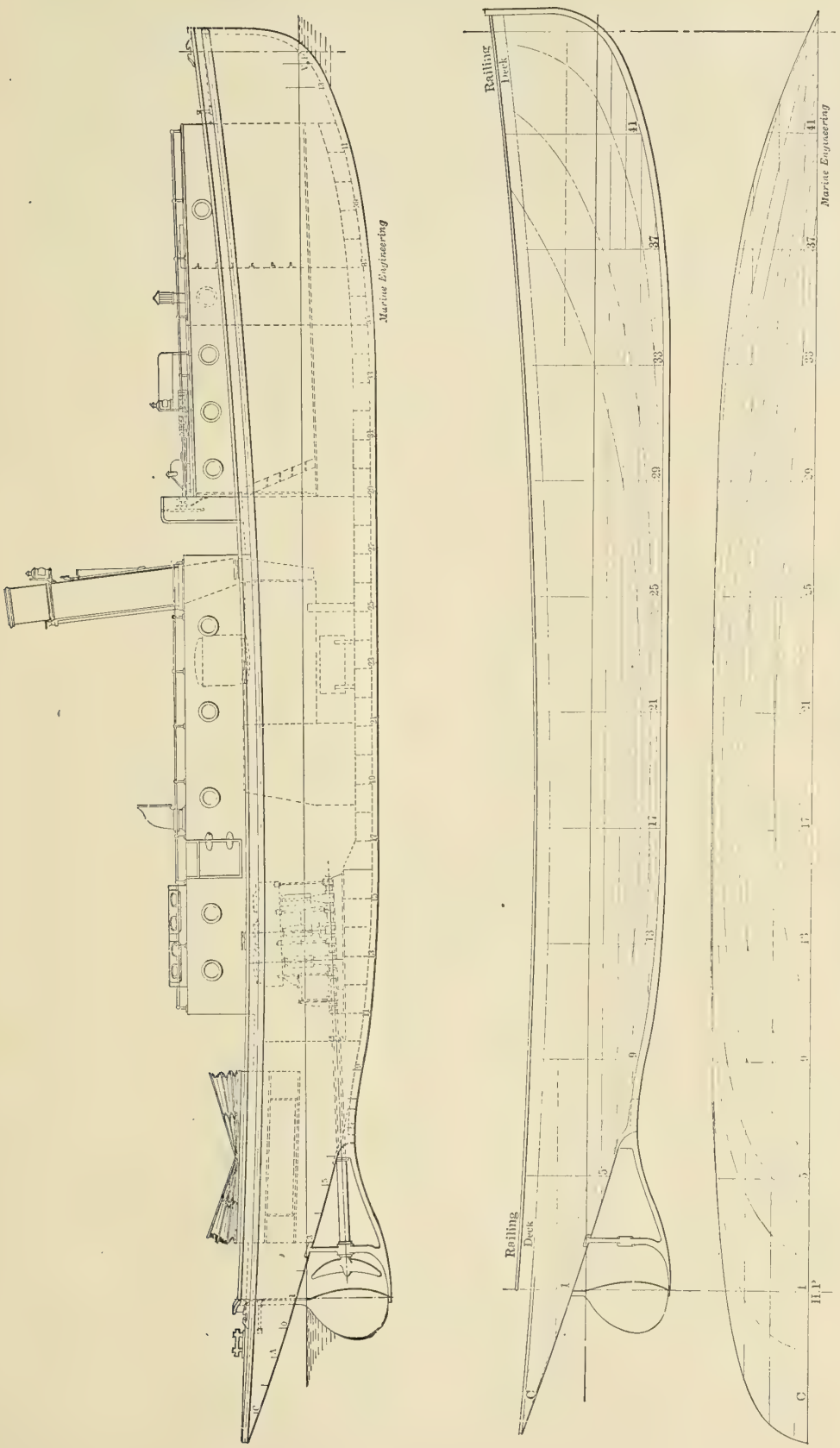
The appearance of the craft is neat, self contained and business like. The comparatively high freeboard together with a continuous plate rail and considerable sheer assure dry decks in a rough sea and allow low




BODY PLAN OF LAUNCH.

deck houses for the necessary inside head room. In the first compartment of the forward deck house, which is entered by an overhead hatch, are accommodations for the pilot and deck hand; immediately aft in the same house are the saloon accommodations of the launch consisting of a closet and sitting room, which is fitted with seats, table and buffet for the accommodation of the police officers when on board. On deck, at the after end of this house, is the pilot's stand, with compass and side lights immediately forward on the deck house. The midship compartment is occupied by the engine, boiler and coal bunkers, and a second low deck house extending over this space gives the needed head room and ventilation for the engineer who is also quartered here while on service. Coal is shipped through scuttles in the deck. On the after deck is an open cockpit for use in fair weather, which will accommodate ten or twelve persons and is protected from the wind and sun by a folding canopy. The body of the launch is carried some eight feet aft of the line of the after perpendicular, which adds to the general appearance and gives clear standing room for the deck hand in approaching and making fast at dock. An awning is fitted which extends from the stack aft and when not in use may be carried under the cockpit floor.

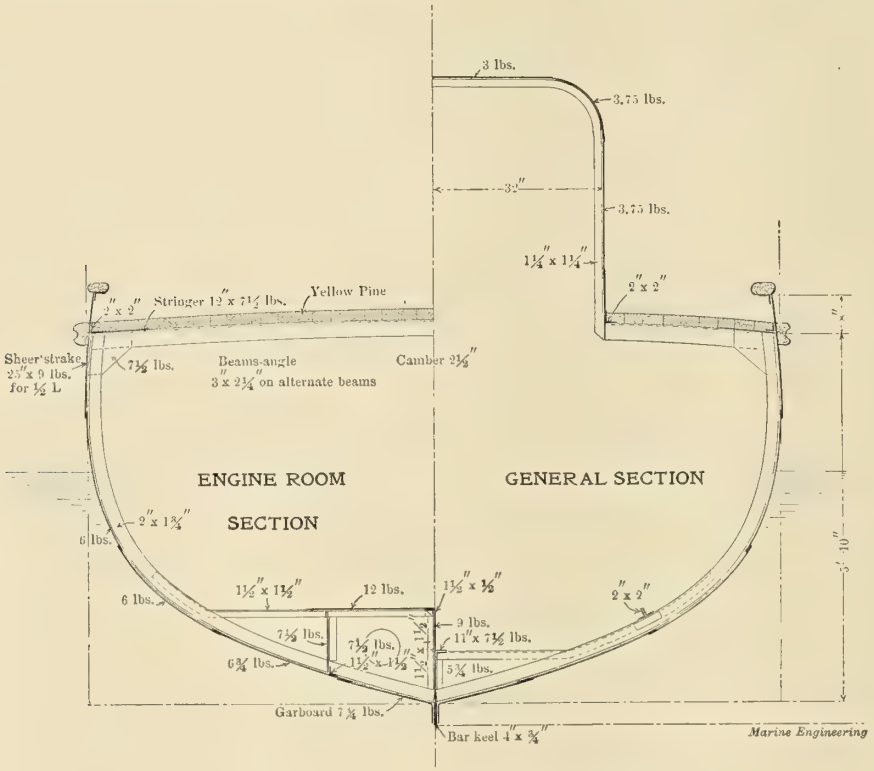
The curve of sectional areas, or more properly the longitudinal disposition of displacement, which is the




ELEVATION AND LINES OF LAUNCH FOR GERMAN POLICE.

factor of hull resistance as far as form alone is concerned, is approximately that given by the two mathematical curves, the trochoid and versine; a modification, however, was introduced in this particular case to throw the center of buoyancy aft of its position, as determined by the curves alone, to give a desired trim when under way. Compared with the stern the forefoot is carried well forward below the water, which throws the center of lateral resistance well forward and tends to swing the boat about its head when moving under the influence of the rudder. This item of handiness is highly desirable when the service is to be, as is here the case, about the docks and the shipping of a frequented harbor. As might be judged from the proportions which it is subjected. When working at normal power these develop a speed of 15 to 16 knots.

The hull is built of steel by the rules of the German Lloyd to class at 100 Ak (E) for harbor service and the construction and workmanship were followed and carefully inspected to insure lightness with sufficient strength to withstand the stresses due to the speed and other conditions. The bar keel 4 inches deep is carried forward continuously to form the stem post and terminates aft in a wrought shape to take the head of the rudder-propeller strut. This bar keel is supported by a 5 3-4 pounds vertical keel plate 8 inches deep, which is carried all fore and aft and stiffened on its upper edge by continuous angles 1 1-2 by 1 1-2 inches. Under the engine the depth of this plate is increased to




MIDSHIP SECTION OF GERMAN POLICE LAUNCH.

of the craft the initial stability is quite low, and it is, therefore, quite easy in a seaway while the high freeboard with the associated reserve buoyancy gives ample range and absolute safety for any extreme condition which might be imposed.

The engine is of the direct acting, three cyclinder, triple expansion type with cyclinder diameters of 8, 12 1-2 and 20 inches and a stroke of 10 inches. Great care was used in the design and construction to produce a simple, light and efficient engine, combined with great durability and strength to withstand the quick hard starts, stops and reverses required by the exigencies of the police service. Steam is supplied by a single locomotive boiler 3.75 feet in diameter and 12 feet in length. This type is used in preference to the more refined water tube boiler because of its greater durability in the severe "on and off" service to 16 inches and its weight to 9 pounds to give additional local strength to bear the concentrated weight of the engine and stiffness to withstand the vibrations developed when running at high speeds. Floors of the same depth as the keel plate are carried out horizontally to the sides and are formed of 5 3-4 pounds plating, except under the engine and boiler where the weight is increased to 7 1-2 pounds to give additional strength and to allow for a certain amount of corrosion which usually occurs at points subjected to high varying temperatures.

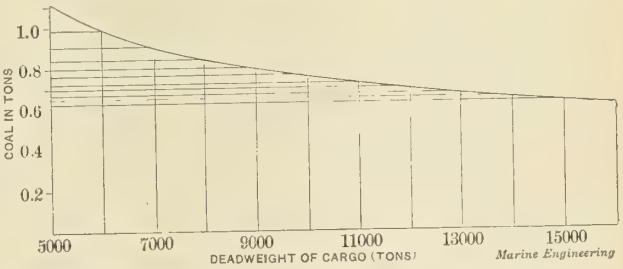
The frame spacing all fore and aft is 18 inches center to center and the frames, all of which are carried to the deck, are 2 by 1 3-4 inch angles. Reverse frames are fitted on each floor and extend from the angles of the vertical keel plate, along the upper edge of the floors, on the frames well clear of the turn of the bilge

where they form the foundation for a bilge stringer of two 2 by 2 inch angles. The deck beams of 3 by 2 1-4 inch angles are fitted on alternate frames and are connected by 7 1-2 pounds bracket plates. A continuous 12 inch stringer of 7 1-2 pound plating is carried on the ends of the beams and a 4 inch tie plate connects them at sides of the deck house. Integral water tight bulkheads are fitted at the ends of the engine and boiler compartment and in addition collision bulkheads are fitted forward and aft to insure safety should an end on collision break open the bow or stern plating. The shell plating which varies from 6 to 9 pounds is fitted in as long plates as practicable and the heaviest weight is in the sheer strake and also at the water line forward, where it gives local stiffness to resist indentation by floating ice.

The rudder-propeller strut is composed of a single composition casting and the balanced rudder used is of the same material. The strut at the propeller shaft head is of an eliptical section with diameters of 4 and 2 inches, while the rudder stock is 2 inches in diameter. All fittings as hand rails, light mounts, chocks, bitts, etc., are of polished brass and the items of equipment as the steering wheel, anchor gear, awnings, etc., are carefully chosen material of high excellence. The interior fittings are of high quality, but in all items, as in the boat itself, preference has been given to a dignified comfort and usefulness rather than yachtlike extravagance.

## Economy per 100 Ton-Miles of Large Cargo Carriers.*

Improved economy in the oversea transport of commerce is being sought for now in the greater size of cargo steamers, the fuel consumption of which does not increase in the same ratio as the cargo capacity. This point is illustrated in the diagram, which shows the coal consumption per twenty-four hours for each 100 tons of cargo carried in vessels of progressive size, each steaming 13 knots. The particulars of the various ships upon whose performances this diagram has been based, are set out in the table. It will be seen in the first place that the weight of the ship itself does not increase in quite the same proportion as the cergo capacity, the immersed area increases at a slower rate than the load displacement, and the power necessary for a given speed advances at a correspondingly lower ratio. Thus, a ship to carry only 5,000 tons requires




COAL CONSUMPTION IN 24 HOURS PER 100 TONS CARGO.

machinery of 3,475 indicated horse power to propel her at 13 knots; while, in the case of a ship of treble the capacity, the power is scarcely double. In other words, the consumption of coal per hundred ton miles in a now relatively small ship taking 5,000 tons of cargo, is eight pounds, while the vessel taking 16,000 tons uses only 4.4 pounds per hundred ton miles, the rate of consumption per unit of power per hour being assumed in all cases at 1.5 pounds. Not only is the fuel consumption less, but the first cost per ton carried need not be greater, and the working expenses generally are lower.

This is because mechanical means are introdcued more freely for many purposes connected with the operation of the ship, while the personnel and all expenses which depend upon it do not increase in proportion with the size.

PARTICULARS OF CARGO STEAMERS FOR NORTH ATLANTIC TRADE, TO ILLUSTRATE FUEL ECONOMY OF LARGE CAPACITY SHIPS.

| Dimensions. | Draught. | Displacement. | Coefficient of Displacement. | Deadweight. | Speed at Sea. | I.H.P. | D. ⅔ constant. | Area Immersed. | Girth Immersed. | Coal per 100 ton-miles.* |
|---|---|---|---|---|---|---|---|---|---|---|
| ft. ft. in. ft. in. | ft. in. | tons. | | tons. | knots. | | | sq. ft. | feet. | lbs. |
| 390 × 45 9 × 29 6 | 24 6½ | 8,640 | 0.69 | 5,000 | 13 | 3,475 | 266 | 1,092 | 87.8 | 8.0 |
| 415 " 48 9 " 31 0 | 25 6 | 10.240 | 0.696 | 6,000 | 13 | 3,725 | 277 | 1,209 | 92.46 | 7.1 |
| 438 " 51 5 " 32 8 | 26 3½ | 11,870 | 0.702 | 7,000 | 13 | 3,970 | 287 | 1,314 | 96.46 | 6.5 |
| 458 " 53 9 " 34 0 | 27 0½ | 13,500 | 0.71 | 8,000 | 13 | 4,225 | 295 | 1,412 | 100.0 | 6.05 |
| 475 " 55 9 " 35 5 | 27 11 | 15,100 | 0.715 | 9,000 | 13 | 4,475 | 300 | 1,513 | 103.64 | 5.7 |
| 493 " 58 0 " 36 7 | 28 7 | 16,750 | 0.72 | 10,000 | 13 | 4,725 | 305 | 1,610 | 107.0 | 5.42 |
| 521 " 61 2 " 38 9 | 30 0 | 19,850 | 0.728 | 12,000 | 13 | 5,200 | 311 | 1,780 | 112.8 | 4.97 |
| 535 " 62 9 " 39 9 | 30 7 | 21,470 | 0.732 | 13,000 | 13 | 5,430 | 313 | 1,862 | 115.4 | 4.8 |
| 548 " 64 1 " 40 9 | 31 3 | 23.070 | 0.736 | 14,000 | 13 | 5,675 | 314 | 1,946 | 118.0 | 4.66 |
| 570 " 66 9 " 42 4 | 32 4½ | 26,150 | 0.742 | 16,000 | 13 | 6,130 | 316 | 2,097 | 122.5 | 4.4 |

*All are Three-Decked Vessels (with Shelter Deck) to Class 100 A 1 at Lloyd's.*

*The rate of consumption is assumed in all cases at 1.5 pounds per I.H.P. per hour.

*Abstract from a paper on the Review of Marine Engineering During the Last Ten Years, read by James McKechnie before the Institution of Mechanical Engineers.

## THE DESIGN OF ENGINES OF VARYING POWERS FROM ONE SET OF DRAWINGS.

BY PROF. H. C. SADLER.

I.

The first point to be settled in the design of a marine engine is that of the most suitable type of engine for the given conditions. These conditions vary considerably even in the merchant marine. For example, the type of engine suitable for a fast passenger vessel is not necessarily the best for a slow cargo boat. In the first case the weight of machinery is a comparatively large percentage of the total displacement, while in the second it is very small. In naval work we see even a greater diversity. Each class of vessel demands an engine of a different type from the others, and hence the torpedo boat, destroyer, small cruiser, large cruiser, and battleship types. These again differ from somewhat similar types in the merchant marine. In the latter service the engine is usually run at its maximum power year in and year out, and one of the most important conditions to be fulfilled is that the economy shall be as great as possible at this power. In the former it rarely happens that it is necessary for a war vessel to use her maximum power except in cases of emergency, and in such cases economy is not of such vital importance as in the previous case. Many other conditions also, such as weight, speed, space available, etc., influence the choice of type of engine for any given case.

The question of the best type of engine for a given set of conditions is beyond the scope of the present article, so we will assume this to have been decided upon.

The power that the engine is to develop, the boiler pressure, and in a general way the piston speed, are known. In ordinary cases the design would be commenced by first assuming a mean effective pressure referred to the low pressure cylinder, and from this the diameter of this cylinder obtained. A suitable ratio of high to low and intermediate would then be chosen and the diameter of the cylinders fixed.

Having the sizes of cylinders, the thickness of the various parts, diameters of shafting, piston rods, connecting rods, etc., must then be figured out before the design can be commenced. All this of course takes time, and in the meantime perhaps the pattern makers are waiting for the plans.

Now amongst our drawings perhaps we have one set of an engine of the same type as the one we are at present designing, but the power that it developed was perhaps a little more or less than that required of the new one. In every other respect the engine already constructed would fulfil the conditions laid down. The question then arises, Cannot we use the plans of the former engine for the new one without going through all the work of re-designing it for a slightly larger or smaller power? This may be easily done, as will be shown later, provided certain conditions are adhered to.

Before proceeding to show how this may be done, it is as well to consider first of all in a general way, what are the principal conditions which influence the power developed by an engine, and what are those which govern the sizes of the different parts. In other words how does the power of the engine vary with the dimensions, speed, and pressure, and how are the stresses on the various members influenced by these items?

In the first place, the power of the engine may be expressed by the well known formula:

$$\text{I. H. P.} = \frac{2\,P\,L\,A\,N}{33{,}000}$$

Where P is the mean pressure referred to the L. P. piston,

L is the length of stroke,

A is the area of the L. P. piston,

N is the number of revolutions per minute.

The product 2(LN) is what is usually known as piston speed. Piston speed is one of the principal items which fixes the type of engine. At one extreme we have the slow running cargo vessel and at the other the fast running torpedo boat. Between these limits, of say 500 feet per minute to 1,200 feet per minute, all the different types lie. So we may take it for granted that the piston speed for any one type is practically fixed within small limits. If the piston speed is increased, either by increase of stroke or revolutions, the power of the engine is increased in the same proportion (other things remaining the same); or the power varies directly as the piston speed.

The factor A in the above formula represents the area of the L. P. piston. Expressed in the usual form, $A = \pi D^2 \div 4$ where D is the diameter. Here it will be noticed that the part of the expression $\pi \div 4$ is constant, and that if the diameter be increased or decreased, the area will increase or decrease as the square of the diameter.

From the formula, the power depends upon the area of the piston if the other quantities remain constant; so, for example, if the area be doubled the power will be doubled. But as we saw above, the area varies as the square of the diameter; hence the power developed will vary as the square of the diameter. Seeing that the diameter is a linear dimension, we may say that the power varies as the square of the dimensions, provided the pressure and piston speed are constant.

With regard to the remaining item in the formula, viz.: the mean pressure P, provided the variation in boiler pressure is not great and other things remain the same, the power will vary approximately as the pressure.

In the case that we propose to deal with, however, the pressure is assumed to remain constant.

To summarize then, the power of an engine varies as the piston speed, as the square of the dimensions, and approximately as the pressure.

We shall now discuss the various stresses in a general way. The stresses may be divided into two kinds: (1) those due to the pressure of the steam and weight of parts, commonly called static stresses; (2) those due to the motion of the engine, or dynamic stresses.

Let $p$ pounds per square inch be any pressure in the cylinder. Then the total load on the piston will be $p$xA pounds. This load is transmitted through the piston rod, connecting rod and crank, to the shaft. The size of each of these members must be such that the stress per square inch in the material does not

exceed a certain amount. Now if we increase the diameter of the cylinder, the total load as shown above will vary as the square of the diameter, and hence the stress in all the various members will be increased in the same ratio. But if the diameter of these members be increased in the same ratio as the increase in the cylinder diameter, their sectional areas will increase as the square of the diameters, and hence the stress per unit of area will be the same as before. In other words, if the pressure remain constant and the diameter of the cylinder be increased, the diameter of the piston rod, connecting rod, etc., must be increased in the same proportion in order that the stress in each of these may remain the same as before.

With regard to the thickness of the cylinder walls, the total pressure acting upon these tending to burst them may be represented by $p$xD. If for example, the diameter is doubled the new pressure will be $p$x2D. If we call $t$ the thickness of material then in the first case the stress will be represented by $p$D ÷ $t$, and in the second case we must double the thickness for the same stress for $p \times 2D \div 2t = pD \div t$, that is, the stress remains constant if the thickness of cylinder walls varies as the diameter of cylinder, or more generally varies as the dimensions. The above, it will be seen, is simply equivalent to the alteration of the scale of the drawings, because we have simply doubled all dimensions. Hence we may say that the stress per unit area due to tension or compression (say in pounds per square inch) remains the same whatever the scale.

The same is true for the stress due to bending. The stress due to bending may be expressed by $p = Y M \div I$. Where $p$ = stress per square inch, Y = distance of farthest particle from the neutral axis, M = bending moment, and I = moment of inertia of the sectional area. The total load as seen above varies as the square of the dimensions, hence the bending moment as represented by $W \times l$ will vary as the cube of the dimensions. In general, let us call $d$ the dimensions: then

M varies as W$x l$; i. e., as $d^2 x d$; i. e., $d^3$.

Y varies as $d$.

I varies as $d^4$.

Hence $p$ varies as $dx d^3 \div d^4 = 1$. That is, $p$ is constant and independent of the dimensions or scale.

The same reasoning shows that the torsional stresses are also independent of the dimensions.

If the stress per unit area remain the same then the general conditions of safety of the whole engine will remain the same whatever the scale.

We have shown that, so far as the statical or steam stresses are concerned, the stress will remain the same whatever the scale of the drawing.

We will now turn to the second class of stresses, viz.: the dynamical ones, or those due to the motion of the engine.

At each end of the stroke the motion of the reciprocating parts must be reversed, and from the first principles of dynamics we know that it is necessary to supply a force in order to alter the motion of a body. This force must be sufficient to overcome what is known as the inertia of the reciprocating masses, such as the piston, piston rod, cross-head, and part of the connecting rod, and has its maximum value at the ends of the stroke. This force will also cause a stress in the material of the various members. The expression for the value of this at the ends of the stroke may be put in the form:

$$F = CWN^2L$$

Where F = force due to inertia of reciprocating parts,
W = weight of parts,
N = number of revolutions per minute,
L = length of stroke,
C = a constant.

Let us now see how this force will vary in terms of dimensions. If all dimensions be increased the weight W will vary as the cube of the dimensions or as $d^3$; the stroke L will vary as the dimensions, or as $d$. Therefore F varies as $d^3 x d$. That is, if the revolutions remain constant the stresses due to inertia will rapidly increase as the size increases. If, however, we decrease the revolutions as we increase the size, it is possible to keep these stresses constant. We saw above that the loads on the various parts vary as the square of the dimensions or as $d^2$, so if we let the force or load F vary as the square of the dimensions, the same reasoning as before shows that the stresses in the material will remain constant as the size is varied.

In order that this may be the case the revolutions must decrease as the size increases and vice versa; in other words, the revolutions must vary inversely as the dimensions or as $1 \div d$. The expression for the variation of the force F then becomes—

F varies as $d^3 x d \div d^2$; i. e., as $d^2$.

Turning again to our expression for I. H. P.

$$I.H.P. = \frac{2PLAN}{33{,}000}$$

we see that for constant pressure

I. H. P. varies as $dx d^2 x (1 \div d)$; i. e., as $d^2$,

and the product 2. L. N., or in other words, the piston speed varies as $dx(1 \div d)$ or is constant. Thus one of our first conditions is fulfilled; namely, that for a given type of engine the piston speed should remain constant.

The general conclusion that we have arrived at is that if the piston speed and pressure remain constant (that is, the type of engine remains constant), the power will vary as the square of the dimensions and the stresses on the various members will be constant, whether the size is increased or decreased. In other words, since alteration in size simply means an alteration of the scale of the drawings, we see that the stresses on the various parts are independent of the scale, and by simply increasing or decreasing the scale of the drawing we may design a new engine of greater or less power than the original one, and be sure that the conditions of safety are the same.

In order to determine our new scale, or the factor by which the original dimensions must be multiplied, in order to obtain the new dimensions, we proceed as follows. We have already seen that I. H. P. varies as the square of the dimensions. Let $(IHP)_1$ be the horse power of the original engine and $(IHP)_2$ that of the new one, and let $d_1$ be any dimension of the original and $d_2$ the same for the new engine.

$$\text{Then } \frac{(IHP)_2}{(IHP)_1} = \frac{(d_2)^2}{(d_1)^2} \text{ or, } \frac{d_2}{d_1} = \sqrt{\frac{(IHP)_2}{(IHP)}}$$

$$\therefore d_2 = d_1 \times \sqrt{\frac{(IHP)_2}{(IHP)_1}}$$

That as if we multiply all the original dimensions by the square root of the horse power ratio we shall obtain an engine which will give us our required new horse power, $(IHP)_2$.

The practical application of this method will be discussed in a following issue.

### Explosion of the Boiler on the City of Trenton.

An investigation into the causes of the explosion of the port boiler of the *City of Trenton*, whereby twenty-four persons lost their lives on August 28th, has been concluded by the coroner's jury, and the verdict handed in.

The *City of Trenton* was on her way from Philadelphia to Trenton when, without the slightest warning, the port boiler exploded, rising through and tearing out the port side of the vessel above the water line. Fire at once broke out, and within a short time the entire upper works of the vessel were burned.

The boiler was one of two placed in the same fire-room, and was of the locomotive type, but without a steam chest. A later examination of the wrecked boiler showed that a part of the tube plate and the entire crown sheet had been sheared off and bent down and around the forward leg of the boiler. The crown sheet was held in place by swinging side rods, secured to the top of the elliptical arc-shaped shell plate by crow-feet, and to the crown sheet by ears, having the ends of screws riveted over.

All the screw stay bolts pulled through the crown sheet, in most cases stripping off the threads and remaining fast in the outside shell plates. The stay bolts were spaced 10 1-4 inches by 7 3-4 inches. The crown sheet was 1-2 inch thick and apparently made of the very best material, and its greatest height from its center to the shell plate was 22 inches. The top of the cylindrical shell, in which were the flues, was about 4 inches below the top of the firebox shell.

Much conflicting testimony was given before the coroner's jury, but the preponderance of evidence appeared to bring out the following facts:—

The crown sheet was a cherry red, and the holes of the torn out screw stay bolts were elliptical, both facts going to prove that the plate must have been unduly heated, which could only happen with very low water in the boiler.

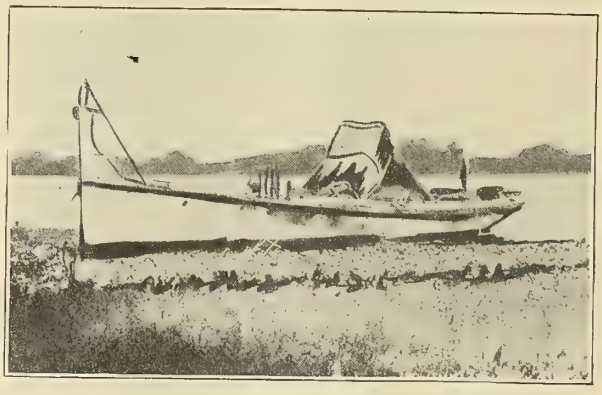
It was found upon test that the safety plug in the boiler, which should have melted at 463 degrees Fahrenheit, did not melt below 695 degrees. The plug was not placed at the hottest point in the boiler, which was above the bridge wall, and the top of the bridge wall was within 18 inches of the crown sheet.

The foreman of the jury closely questioned the United States Inspector of Marine Boilers and his assistant, and although the inspector had granted a certificate, he admitted that he did not know the position of the safety plug in the boiler until after the accident.

The jury, composed largely of experts, and with Mr. Samuel M. Vauclain, of the Baldwin Locomotive Works, as foreman, rendered the following verdict:—

"The cause of the explosion, we find, was due to the crown sheet becoming overheated; that the material and design of boiler were in accordance with the printed regulations as contained in form 2101 and approved by the Secretary of the Treasury in 1901; that the inspection of the boiler had been as complete as the limited force employed by the Government would permit; that we consider the number of men

STEAMBOAT CITY OF TRENTON.

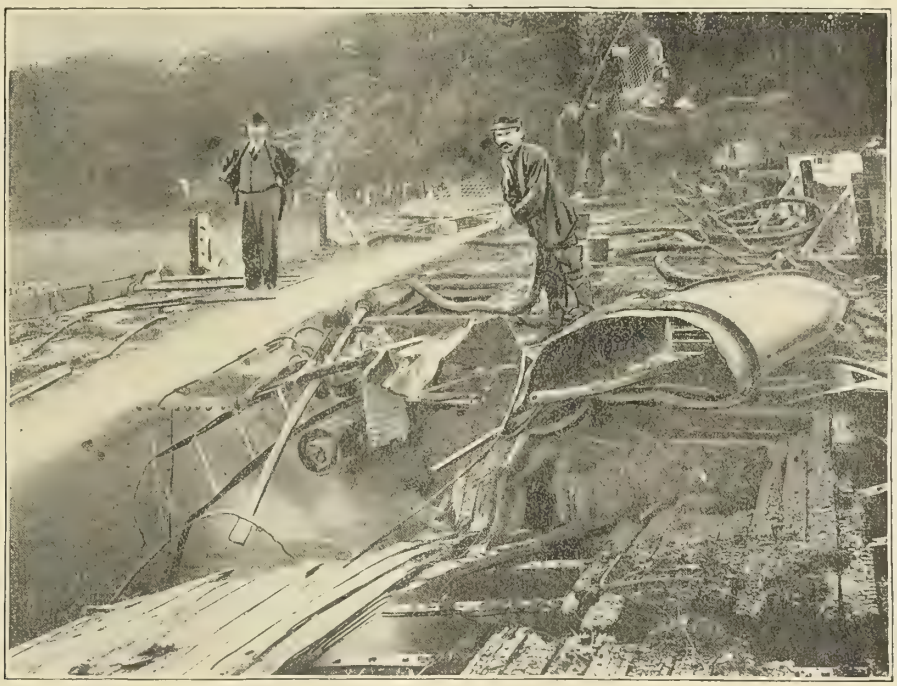


CITY OF TRENTON AFTER THE FIRE.

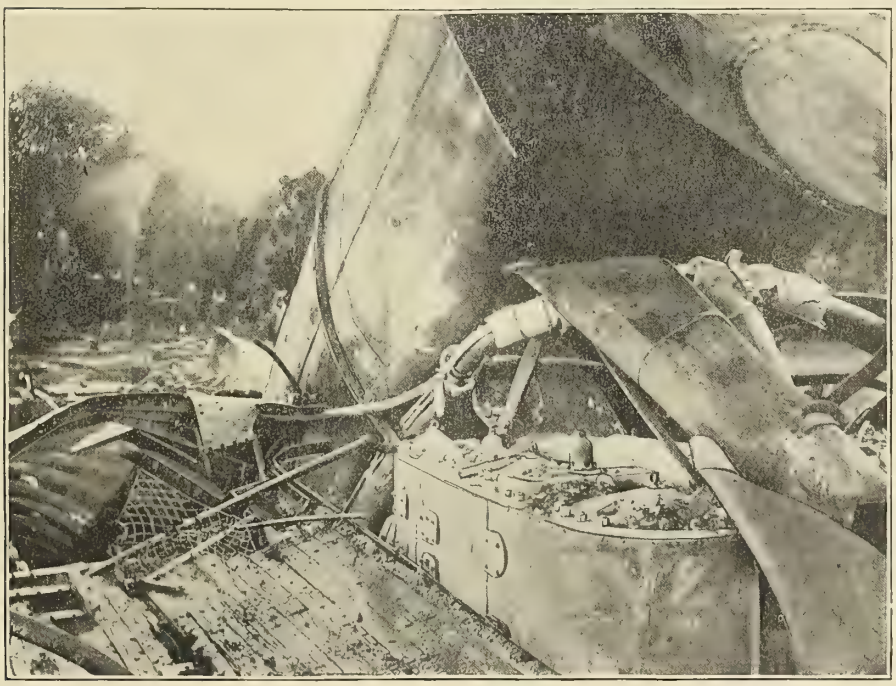
employed by the Government for this work in this district entirely inadequate to secure the best results, and we recommend that the attention of the Secretary of the Treasury be drawn to the matter so that a remedy may be applied as soon as possible; that we do not approve of the operation of a boiler of this design and location, with a bridge wall located in the fire-box, in the manner employed in this boiler, especially when using forced blast on the fires; that if such construction is approved and used, we recommend that the fusible plug should be placed in the center of the crown sheet transversely and directly over the bridge wall; that the requirements of the United States Government rules concerning fusible plugs were not complied with by the Government; that the jury was unable, owing to the conflicting nature of the evidence, and the incompetence of some of the witnesses, to charge criminal negligence against any person or persons connected with the construction and operation of the boiler."

The general subject of boiler explosions is to be

discussed by the members of the Franklin Institute of Philadelphia at some future meeting.



VIEW ON DECK.



STACK CASING AND TOP OF CYLINDERS OF CITY OF TRENTON AFTER THE FIRE RESULTING FROM BOILER EXPLOSION.

**H. W. Cramp Dead.**—Mr. Henry William Cramp, vice president and treasurer of the William Cramp and Sons Ship and Engine Building Company, died early on the morning of October 3, at Devon, from acute pneumonia. Mr. Cramp was the eldest son of Mr. Charles H. Cramp, the president of the company, and was born in Philadelphia in 1851. All his life has been spent in the shipbuilding industry of this country, and he was a prominent figure in the maritime world.

## THE DISPLACEMENT AND DIMENSIONS OF SHIPS.*

BY J. A. NORMAND.

The problem which forms the subject of this paper is the one most frequently proposed to the naval architect; but, although the technical literature increases constantly, he would vainly search, in the vast amount of documents at his disposal, for any simple method of solving it. We have one, it is true, but it is not simple, and consequently it is very seldom used. It is founded on the equation of displacement, of the third degree at least.

There exists another method, this one of extreme simplicity, although derived from the same equation of displacement. It offers the further advantage of showing explicitly the relative influence of each part of the program on the final result.

I will try to explain it as clearly as possible, since, although used by some naval architects, it is probably unknown in this country.

When the plans for a new vessel are to be laid down, the surest and simplest process is to take as a type one or more vessels differing as little as possible from the one to be designed—preferably existing vessels, all the data, partial weights, and results of which are well known, so that the calculations may be based on facts, and not on hypothesis—and to work out the changes required by the slight differences between the programs of the old and the new ship. The possible errors are limited in that case to those that may be committed on slight differences.

If the vessel to be designed is a cargo or passenger boat or a yacht, size forms generally part of the program. Not so in a war vessel, where size and displacement must, in most cases, be reduced to a minimum. This paper deals more especially with war vessels, although the proposed rules may be used with great advantage for all kinds of ships.

We will first suppose that the speed of the vessel chosen as type is not altered, but that weights only are added or suppressed. What will be the displacement of the new ship, supposing her to be exactly similar to, and differing only by scale from, the type vessel, the water line remaining at the same relative height in order that the fineness of lines may not be altered?

It is clear that the difference of displacement must be much larger than the difference of weights, as calculated for the type. If, for instance, the difference of weights is positive, and equal to 300 tons, should the vessel remain unaltered, she would settle down; her resistance would be increased, her lines fuller, her seaworthiness reduced, and so would the speed and the steaming distance. Accordingly, the dimensions must be increased; but as they increase, so will the resistance, the horse-power, the weight of hull, machinery and coals; and this further increase of weights will require a further increase of dimensions and displacement.

Now, is there a simple relation between the weights first added to the type vessel and the ultimate increase of displacement? There is.

According to an approximate law first given in 1885,* the demonstration of which will be found in the Appendix: "The plus or minus difference of displacement must be equal to the plus or minus difference of weights, as calculated for the vessel chosen as type, multiplied by a coefficient K which can be exactly determined and is nearly constant for all classes of vessels (its mean value being about 3.6), in order that the general conditions of the program may be fulfilled.

Knowing by this very simple rule the approximate displacement of the ship to be designed, it is easy to calculate the dimensions, horse-power, weights of hull, machinery, coals, etc., by reference to the same elements in the type vessel.

At the same time, if the value of K has been calculated for the different types of vessels, in any navy, the naval architect is able to know very quickly whether the new program can be carried out without radical changes, such as adopting stronger materials and reducing the scantlings, increasing the immersion and reducing the relative height of freeboard, adopting lighter machinery and boilers, or reducing the fineness of the lines, which can be done within certain limits, by a slight increase of power, provided the relative propulsive surface be augmented.† The new method enables us to estimate the consequences of any of these modifications on the size of the vessel to be designed.

The rule does not apply so well to first-class battleships and cruisers—that is to say, the coefficient must then, as experience has shown, be lowered down to 2.8 and 2.5, because the law of similitude, on which it is based, does not hold good in that case. The transverse dimensions of those very large vessels remain generally constant, since the draught of water and the statical stability cannot be increased, the difference in size depending almost entirely on the difference in length.

Before going further it may be well to show how easily this rule may be applied.

Let me take as a type a cruiser resembling somewhat the *Diadem*, with Belleville boilers, and suppose the particulars of this type to be:

| | |
|---|---|
| Length | 435 ft. 0 in. |
| Beam | 69 " 0 " |
| Mean draught | 25 " 3 " |
| Midship section | 1,430 sq. ft. |
| Displacement | 11,000 tons |
| Maximum speed at above displacement | 20 knots |
| Coresponding indicated horse-power | 16,500 |

Let the partial weights be:

1. *Weights Varying as the Displacement.*

| | |
|---|---|
| Hull, complete with accessories, but without wood and copper sheathing | 4,200 tons |

* Paper read before International Engineering Congress, Glasgow, 1901. Section IV.: Naval Architecture and Marine Engineering.

* "Etude sur les Torpilleurs," by J. A. Normand. An English translation of this pamphlet was published by the United States Office of Naval Intelligence in "Papers on Squadrons of Evolutions," June, 1886.

† See "Sur les Avantages que presente pour les Navires de Guerre, la combinaison d'une faible acuité et d'une grande surface propulsive." (Bulletin de l'Association Technique Maritime No. 12, 1901.)

*2. Weights Varying as the (Displacement)$\frac{2}{3}$*

| | |
|---|---|
| Wood and copper sheathing, machinery, boilers, etc., coals necessary for steaming a certain distance at a given speed and for all auxiliary services, crew and effects, provisions, fresh water, boats..... | 5,500 tons |

*3. Weights Independent of the Displacement.*

| | |
|---|---|
| Guns, ammunition, turrets and accessories, hoists, blockhouse, torpedoes and tubes... | 1,300 tons |
| Total, equal to displacement.. | 11,000 " |

$$K = \frac{11{,}000}{11{,}000 - 4{,}200 - \frac{2}{3}\,5{,}500} = 3.51.$$

Now, what would be the displacement and dimensions of a similar vessel, where:

1. Small tube boilers are substituted for Bellevilles; the speed, steaming distance, thickness and distribution of armor, weight of guns and ammunition, etc., remaining the same?

2. Cylindrical boilers, substituted for Bellevilles; the other conditions, speed, etc., as above, remaining the same?

3. Small tube boilers substituted for Bellevilles; the weight of guns, etc., reduced by 35 tons, the weight of armor reduced by 20 tons, and the steaming distance increased by 30 per cent. (assuming the weight of coals to be 2,000 tons at 11,000 tons displacement), the speed remaining the same?

FIRST PROBLEM.

The weight of small-tube boilers (Normand's, for instance, with tubes 1 1-2 inches outside diameter, instead of 1 1-4 inches in destroyers) is about 20 per cent heavier per square foot of grate than Belleville's; but the combustion for the same unit may be larger in cruisers by 70 per cent (34 pounds per square foot of grate—that is to say, less than one-half the rate of combustion in destroyers, instead of 20 pounds), the evaporative duty being the same, so that the relative weight of small tube and Belleville boilers per indicated horse-power is about

$$\frac{1.20}{1.70} = 0.70.$$

The weight of Belleville boilers and fittings in the *Diadem* (of 16,500 indicated horse-power, as in the type) being 748.4 tons, the saving in weight would be $(1 - 0.70)\ 748.4 = 225$ tons.

Accordingly the displacement would be reduced by

$$225 \times 3.51 = 7.90 \text{ tons}$$

and would become 10,210 tons.

Ratio of dimensions of the hull

$$\sqrt[3]{\frac{10{,}210}{11{,}000}} = 0\ 9754$$

$$\text{Power: } 16{,}500 \left(\frac{10{,}210}{11{,}000}\right)^{\frac{2}{3}} = 15{,}700 \text{ I. H. P.}$$

The weight of coals is reduced in the same ratio as the power, to keep the same steaming distance.

Weight of machinery, boilers, propellers, etc.: This weight being 1436.7 in the *Diadem*, we have

$$(1436.7 - 225) \left(\frac{10{,}210}{11{,}000}\right)^{\frac{2}{3}} = 1153 \text{ tons.}$$

SECOND PROBLEM.

From Sir John Durston's paper* it appears that the saving in weight of boilers and machinery due to the substitution of Belleville for cylindrical boilers, working at a lower pressure, is, at least, 650 tons, the maximum rate of combustion being 20 pounds per square foot of grate for Belleville and 30 pounds for cylindrical boilers.

The relative importance of the extra weight is too great in this case to allow the use of formula (2). We must take the formula

$$K = \frac{11{,}000}{11{,}000 - 4200 - \frac{2}{3}(5500 + 650)} = 4.073$$

The displacement of the type increases by

650 tons $\times$ 4.073 = 2647 tons and becomes 13,647 tons.

Ratio of linear dimensions of the hull.

$$\sqrt[3]{\frac{13{,}647}{11{,}000}} = 1.075.$$

$$\text{Power: } 16{,}500 \left(\frac{13{,}647}{11{,}000}\right)^{\frac{2}{3}} = 19{,}060 \text{ I. H. P.}$$

The weight of coals being increased in the same ratio to keep the same steaming distance.

Weight of machinery, boilers, propellers, etc.:

$$(1476.7 + 680) \left(\frac{13.647}{11{,}000}\right)^{\frac{2}{3}} = 2410 \text{ tons.}$$

It is prudent, especially when the extra weights are very important, to verify that no error has been made in the calculation. Here we have for the new ship:

2. Weights varying as $\left(\text{displacement}\right)^{\frac{2}{3}}$

| | Tons. |
|---|---|
| $4200 \times \frac{13{,}647}{11{,}000}$ ... ... ... | 5,210 |

2. Weights varying as displacement$-\frac{2}{3}$

| | |
|---|---|
| $(5500 + 650) \left(\frac{13.647}{11{,}000}\right)^{\frac{2}{3}}$ ... | 7,110 |

3. Weights independent of the displacement ..... 1,300

Displacement of the new vessel... 13,620

instead of 13,647 tons. The difference is of no importance.

From the above it appears that the displacement of a cruiser of the type selected varies approximately from 10,210 tons to 13,647 tons; in other words, increases by one-third according as she has small tube high-pressure or cylindrical ordinary boilers, working at a lower pressure, all the other conditions of the program—speed, weight of guns and ammunition, thickness and distribution of armor, steaming distance, etc.—remaining the same.

THIRD PROBLEM.

Extra Weights as Calculated for the Type.

| | Plus. | Minus. |
|---|---|---|
| Boilers, as above..... | .. | 225 |
| Guns and ammunition..... | .. | 35 |
| Armor ..... | .. | 20 |
| Coals, 2000 $\times$ 0.30..... | 600 | .. |
| | 600 | 280 |

Increase of weights, 320 tons.

The displacement would increase by

* Transactions of the Institution of Naval Architects, 1898.

$$320 \text{ tons} \times 3.51 = 1123 \text{ tons},$$

and become 12,123 tons.

Ratio of linear dimensions of the hull:

$$\sqrt[3]{\frac{12,123}{11,000}} = 1.033.$$

$$\text{Power: } 16,500\left(\frac{12,123}{11,000}\right)^{\frac{2}{3}} = 17,600 \text{ I. H. P.}$$

Weight of machinery, boilers, etc.:

$$(1436.7 - 225)\left(\frac{12,123}{11,000}\right)^{\frac{2}{3}} = 1292 \text{ tons.}$$

Weight of coals:

$$2000 \times 1.30\left(\frac{12,123}{11,000}\right)^{\frac{2}{3}} = 2775 \text{ tons.}$$

FOURTH PROBLEM.

We will now suppose that the only difference in the program of requirements of the vessel to be built and the above typical cruiser consists in an increase of speed of one knot. The fineness of the lines of the type must be increased, which cannot be done generally without reducing the displacement to suit the new speed, so that the coefficient of performance—

$$\frac{\text{Midship section} \times (\text{speed})^3}{\text{I. H. P.}}$$

should remain the same, and the power must be augmented, for the type, in proportion to the cube of the speed.

The reduction of displacement due to increase of fineness is found by the formula:—

$$\triangle D_v = 0.037 \times (1430)^{\frac{5}{4}} 100 K = -325 \text{ tons.}$$

or by the formula:—

$$\triangle D_v = -\frac{0.0286 \times 1430 \times 435 - 11.000}{} = -339 \text{ tons.}$$

We will adopt a mean value of — 330 tons.

The weight of machinery, boilers, etc., $P_m$ of the type being equal to 1436.7 tons, we have:—

Displacement of the new ship.

$$D = 11,000 + 2.51 \times 330 + 3 \times 3.51 \times \frac{1}{20} 1436.7 = 12,585 + 3 \times 3.51 \times \frac{1}{20} \times 1436.7 = 12,575 \text{ tons.}$$

Ratio of displacement of the new ship and of the type altered to suit the new speed: 21 knots.

$$\frac{12,585}{11000 - 330} = 1.180.$$

Ratio of linear dimensions

$$\sqrt[3]{1.180} = 1.057.$$

Ratio of indicated horse-power and of weight of machinery and boilers:—

$$\left(1 + \frac{3}{20}\right)(1.180)^{\frac{2}{3}} = 1.284$$

From the above we see that, in a cruiser of the type considered, an addition of 1 knot to the 20 knots of the type vessel leads to an increase of about 18 per cent in the displacement and of 28 per cent in the power, the thickness and distribution of armor, steaming distance at a constant speed, and weight of guns, ammunition, etc., remaining the same.

The increase would be still greater if the steaming distance were partly measured at a speed proportional to the maximum. It ought to be so, since it is useless to give a very high speed to a ship if she is never to make use of it. No quality is more expensive than speed.

The few problems which we have solved by the new method are sufficient to show how easily it may be applied. It elucidates very simply a question which most people and even some naval architects do not clearly realize: the extreme importance of lightness in a warship. How often have we not heard during that everlasting discussion about cylindrical vs. water-tube boilers, that "to save a few hundred tons weight it is dangerous to change a well-known type of boiler for a more expensive one, requiring far greater care in manufacture and working." Even if it were so, it ought to be known that the saving is not those few hundred tons weight, but about 3 1-2 times this amount.

The immense advantages resulting from a reduction in the weights of war vessels will certainly lead sooner or later to the adoption, not of small water-tube, but of mean water-tube boilers of some type or other capable of standing a high rate of combustion. Even this alteration will not be sufficient if the race for speed continues.

Steel of high tensile strength will be needed for the hulls of large vessels; but the greater part of the advantages to be derived from its use will be lost until equally strong steel, not hardening when riveted hot, can be commercially and surely produced.

In this paper I have dealt only with large vessels, the speed of which corresponds always to the descending part of the curve of the coefficients of performance. The principles laid down may equally well be applied to small high-speed vessels, such as destroyers and torpedo boats; but it must not be forgotten that their maximum speed always corresponds to the ascending part of the curve, so that the fineness of the lines need not be altered when the maximum speed changes, and that the power may be proportioned to the square of the speeds.

We have seen that, on the contrary, in large vessels the power varies as the cube of the speed when the fineness is altered to suit the new speed, or to a higher power if the fineness remains the same. Extreme speed is relatively less expensive in a small vessel than in a large one.

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### The America's Cup Races.

Another contest for the America's Cup has come and gone and the trophy still remains on this side of the Atlantic. The races this year have attracted even more than common interest, due to special features which have from time to time arisen. The keen competition between the *Columbia* and *Constitution*, the result of which was in doubt until the very last, attracted widespread attention, and doubtless many believe that the question of superiority between the two yachts is by no means definitely settled. Whatever further trials may prove regarding these two yachts, it is sure that they are very closely matched and that either is a worthy representative of the best that America has to offer. It may furthermore be fairly assumed that the individualities of the *Constitution* are not as well known as those of the *Columbia*, and that from the very nature of the case the best rig, cut and fit of sails, etc., are not as well known for the newer as for the older boat.

Without partizanship for either boat and in the interests of scientific accuracy it may be assumed that when time shall have given opportunity for studying the individualities of the *Constitution* as thoroughly as those of the *Columbia* have been studied, and with everything as harmoniously adjusted on one boat as on the other, it is quite within the limits of probability that the newer boat may prove the faster of the two.

No one in fairness, however, can in the least blame the decision of the committee in selecting the older boat, especially in view of the final result. Had the result been different and had *Shamrock II.* taken the cup back across the Atlantic, doubtless there would not have been lacking those who would be ready to lay such disaster to the wrong choice of boat. From the American point of view, perhaps either was good enough to do the trick, but the work of the *Columbia* was more consistent and steady in the trial races, and the committee doubtless felt that in selecting her they were taking the fewest chances on the final result.

Between the two *Shamrocks* the competition was no less keen, and for a time seemingly as much in doubt. On the whole, however, *Shamrock II.* proved herself the better boat, and this conclusion seems to have been further borne out by the showing which she made in the final races.

In the resumé of the situation it will be unnecessary to refer in detail to the races themselves. The daily press has sufficiently cared for this phase of the question, and the details are already becoming dimmed in competition with other matters of present interest. The first race was won by a narrow margin. The second race in what was considered to be "*Shamrock*" weather was won by a thoroughly decisive margin, while the third was won on time allowance. The actual time was some two seconds less for *Shamrock II.* than for *Columbia,* but the time allowance of 43.7 seconds gave the race to the latter by 41 seconds.

The last was the only race of the three which may be considered as in any way unsatisfactory. From the sportsman's higher standpoint, and certainly from the scientific point of view, winning a race on time allowance can hardly be considered thoroughly satisfactory. There always has been and always must be an uncertainty as to the accuracy with which time allowance can represent the difference between two given boats. We may freely admit that size carries with it some advantage, and that a corresponding allowance should be made. We must equally admit, however, that the present rule, while perhaps as good as any which can be devised, is wholly arbitrary, that it rests on general opinion only, and that there is no assurance whatever that it can represent in any given case the true difference or handicap between yachts of different dimensions. While, therefore, time allowance seems to be a necessary evil, no true sportsman wishes to win a race on such margin alone, while from the scientific standpoint such a result involves too large an element of uncertainty to be of any very great value.

SHAMROCK AND COLUMBIA CROSSING THE STARTING LINE ON THE THIRD RACE, COLUMBIA IN FOREGROUND.

To yacht designers the most interesting question is that presented by the narrow margin of difference between the four boats, *Columbia, Constitution, Shamrock I.* and *Shamrock II.* With boats of this general type and with the size and other general conditions fixed, are we approaching the limits of the possible? It seems likely that such is the case, and that if the conditions remain unchanged the differences between the boats will become less and less as the years go by. A necessary consequence will be the greater and greater importance of the crew and of the rigging and handling of the yacht as independent of her design. Such seems to be the result toward which the evolution of this type of yacht is tending under conditions as they now exist.

### Steam Yacht Anita.

One of the finest large steam yachts in these waters is the *Anita*, which is owned by Mr. George B. Wilson. In many respects she is unique, and her appointments and equipments are very complete. The general dimensions are:

| | |
|---|---|
| Length on deck (from end to end of plank shear) | 187 ft 0 in. |
| Length of water line | 158 " 6 " |
| Beam | 22 " 0 " |
| Depth of hold | 10 " 7 " |
| Draft | 9 " 0 " |
| Gross tonnage | 232.69 tons. |

She was built by William Skinner & Company, of Baltimore, and was launched in June, 1895. In designing this yacht it was the purpose of the owner to have her sufficiently strong to encounter all kinds of weather on the Atlantic, and to lighten the construction she was built partly of steel and partly of wood. Ninety feet of the boat amidships is built of steel angle frames, spaced 12 inches, and steel plating. The ends are of cedar sheathed with 3 inch planking.

The accommodations are exceptionally large and finished in mahogany. As seen in the illustration, there are two deck houses, containing dining room, smoking room, and ladies' saloon. Below decks are four large staterooms and three smaller rooms for guests, and other accommodations for officers and crew.

The cylinders of the triple expansion engine are 16 inches, 24 inches and 36 inches in diameter, with a common stroke of 20 inches. The engine has always given the greatest satisfaction, as it runs with practically no vibration, which is a large consideration for machinery on board yachts. The three Almy water-tube boilers supplying steam at 165 pounds pressure are each 7 feet 9 inches long and 45 inches wide, giving a total grate surface of 81 square feet. At the normal full speed of the yacht which is 15 1-2 knots, the engines develop 950 horse power running at 160 revolutions per minute.

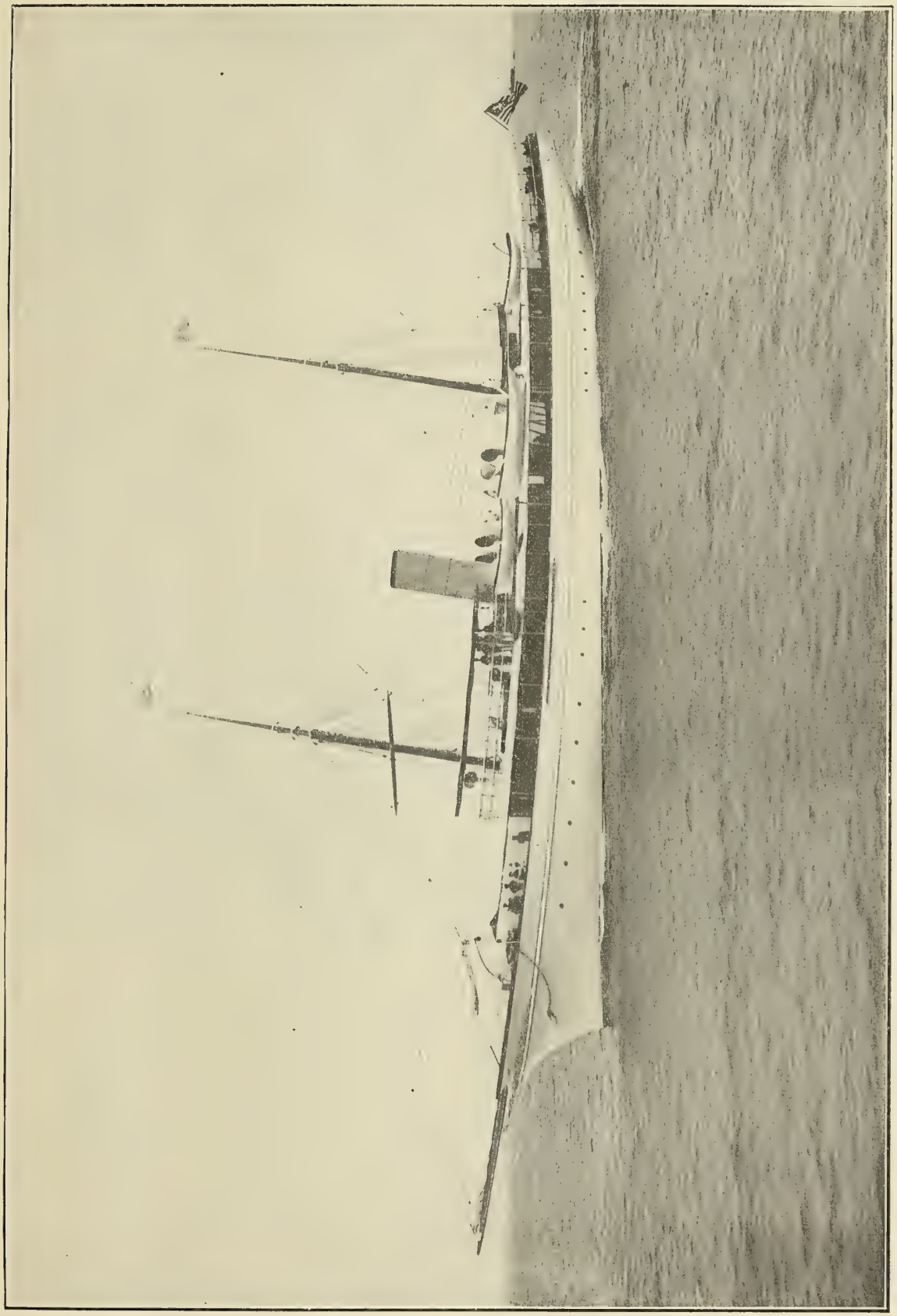
The engine which drives the Crocker-Wheeler generator on the steam yacht *Anita* was built by W. D. Forbes and Co., of Hoboken. It is a counterpart of engines which have been furnished to the United States Navy. It is entirely enclosed by sheet metal. The front and back, however, are so arranged that they can be instantly taken off to get at the piston-rods, valve-stem packing, crossheads, crosshead guides, crank bearings and main bearings, all of which can be easily examined and reached, if necessary.

The oiling system is one which has proved most satisfactory after severe trial, and is accomplished by means of a pump forcing the oil through a system of tubes which lead to all the main bearings up through a flexible joint to the crosshead, back to the slippers and down the connecting rods to the crank brass. The pressure of the oiling system can be varied at will, but from four to twenty pounds seems to be perfectly satisfactory, which, of course, is quite a wide range. This forced system is becoming extremely popular where engines are likely to be severely taxed and when running at high speeds, and is almost a necessity for the best results under such conditions. Katzenstein's metallic packing is used throughout on the engine, and the stuffing boxes are unusually deep. The regulation is obtained by an automatic governor made under the patents of Mr. F. M. Rites, and is of the very simplest construction, there being practically but two pieces outside of the spring and the suspension pin, namely, the weight and the standing arm, which is keyed fast to the crank shaft. The peculiar shape of the governor weight, which is almost universally mistaken for a fly-wheel, is adopted simply for the reason that if the weight was a true circle it would offend the eye. As the load varies from time to time, this circle would at times run almost concentrically, and again very excentrically, therefore the rim of the weight is broken up so that the excentric movement may not be noticed.

There is also installed upon this yacht a large storage battery, having a capacity of 240 ampere hours, or about one hundred 16 candle-power lamps, for five consecutive hours. This battery is arranged in two banks, each bank containing thirty cells. These banks are connected at the switchboard so that the battery can be charged in multiple direct from the bus-bars when the dynamo is running at its normal voltage of 110, the surplus voltage being taken up in the large dimmer. The battery is so arranged that it can be used on the lights alone; it can be charged from the bus-bars while the whole boat is being lighted, or it can be run in multiple with the dynamo at will. There are in all three belts on the yacht, and one searchlight. There is one main belt passing from the bow to the top of the foremast, from there to the mainmast and down to the stern. This belt is made up of four large jute-filled conductors, and so connected that there are three distinct belts in the one, so that red, white and blue lamps can be used and manipulated separately. All of the belts and the searchlight are controlled from the second switchboard, located in the upper engine room. There are three switches in the main belt controlling the red, white and blue lights independently of each other, and also a four-pole switch for throwing on or off all three of the colors at once. The main belt is composed of 165 lights in all—55 red, 55 white and 55 blue. Arranged on the foremast is a large belt consisting of 120 lights, which forms the letter "A," the initial letter of *Anita*. This is controlled, together with the searchlight receptacle, from the switch on the switchboard in the upper engine room. The third belt leads around the outside of the yacht, under the awning, and consists of forty lights on each side, or eighty in all. These are controlled by independent switches on the upper switchboard.

The normal capacity of the dynamo is 191 amperes; the normal capacity of the searchlight 45 amperes. During the night of the test the entire boat, all three of the belts and searchlights, were lighted and in operation at the same time, making a total of 575 16-candle-power lamps, calling the searchlight equivalent to 90 lamps. This makes a total of 287 amperes. This was carried upon the machine and battery working in multiple, the dynamo carrying 225 amperes, and the battery carrying 62 amperes, for three hours consecutively without any sign of either being overloaded.

The arrangement of the switchboard is such that it is almost impossible for the attendant to make a mistake in the manipulation of the dynamo and battery.



STEAM YACHT ANITA BELONGING TO MR. GEORGE B. WILSON.

## INSTALLING A PROPELLER SHAFT WITHOUT DOCKING.

BY COMMANDER H. WEBSTER, U. S. N.

In these modern days of new and improved methods of carrying out mechanical ideas and operations, it is interesting to note the fact that individuality counts for more and more as complexity in function increases, and it is undoubtedly true that a large share of this country's mechanical supremacy is due to what may be termed "the initiative of the individual."

Precedent has comparatively little weight when the question of "how to do it" comes up, and as the average American realizes the truth of Franklin's aphorism that "time is money," he is always on the lookout for methods of procedure which shall accomplish the sought for end in the least time, with the minimum of expense.

The torpedo boat *Shubrick*, built by the William R. Trigg Company of Richmond, Va., was launched before the installation of her propeller shafting. This was done for several reasons, the principal one being delay in the delivery of the shafts by the contractors. The necessity for clearing the ways for other work was also an important factor. The *Shubrick* was launched on the last day of October, 1899, but the propeller shafts were not ready for installation until March, 1900. Richmond, at that time, was unprovided with docking facilities, the nearest dry-dock being at Norfolk, some hundred or more miles distant, and it became a question of considerable moment in time and money, as to whether the long trip, in tow, and the cost of docking could be obviated.

The problem was promptly solved by the builders' determination to raise the stern of the *Shubrick* out of water to a height sufficient to permit the work of shaft installation to be carried on from floats alongside and under the vessel. The success with which the scheme was carried out from start to finish, from both a mechanical as well as monetary point of view, makes the incident well worthy of notice by shipbuilding and engineering experts.

It is usually held that the modern steamship, complete, but unburdened, is in the condition of a single bridge element capable of withstanding suspension through the center of gravity, without sensible flexure. However true this may be as a general proposition, like many another hypothesis, it holds only within narrow limits, for if the attempt were made to suspend a steel ship of any considerable dimensions on a point in the keel within the vertical of the center of gravity of the vessel, the result would probably be disastrous.

The normal strains affecting a floating structure are those incident to equability of stress over a large percentage of the area of the floating body, this equability of stress being due, of course, to the mobility of the suspending element.

TORPEDO BOAT SHUBRICK READY FOR LAUNCHING FROM THE YARD OF WILLIAM R. TRIGG COMPANY.

The method for the installation of the propeller shafts of the torpedo boat *Shubrick* is notable for two things, its simplicity and efficiency. As can be seen from the photograph, the operation included no more mechanism than would be involved in hoisting any given weight—the slings, or straps, passing under the stern of the boat, the hoisting mechanism, and the use of the hoisting platform for the carrier of the shafts to be installed. About the only detail in the operation not patent to the eye, in this photograph, is that the bow of the *Shubrick* was depressed by the admission of about twenty-two tons of fresh water into the forward compartment, facilitating the emersion of the stern and adding to lateral stability during the suspension. The smooth water was a favorable condition, the fact remaining, however, that the whole operation reflected credit upon the contractors, and evidenced the faith held in the excellence of the hull work.

The photographs illustrating this article need no de-

scription, for they tell their own story, rendering any account of the method employed unnecessary.

It may be noted, however, that the extreme length of the vessel was 175 feet, and the approximate length from point of emergence to perpendicular stern line was 62 1-2 feet, somewhat more than one-third of her total length. The hull plating is one-eighth inch thickness, and a careful examination made during the suspension of the *Shubrick* stern out of water, failed to show that undue stress was imposed on framing or plating, and the fact that the shafting was emplaced without difficulty was additional evidence that no deformation resulted from the operation.

Inspection of the illustrations shows that the angle of the screw under the load of the *Shubrick* was brought very close to that of the hull of the torpedo boat, rendering the installation of the shafts a comparatively simple matter after the stern of the vessel was raised.

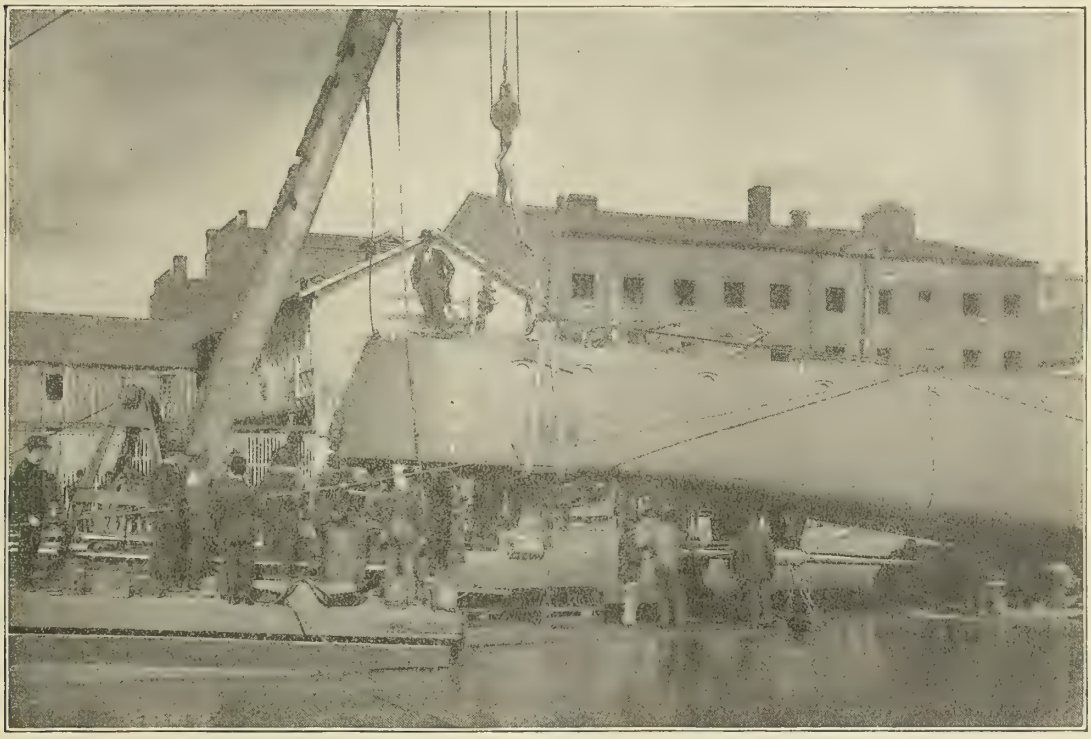
A comparison in time and money between the cost of docking and the cost of the method here noted serves to show the economy of the latter Docking at Norfolk or Newport News, including towing, added insurance, delay in work estimated at seven working days, $1,000. The expense incurred by the method adopted is given from the books of the contractors as follows:

| | |
|---|---|
| 15 men from machine dept..... | $70.97 |
| 20 men from shipyard ..... | 51.35 |
| Use of derrick for 17 hours..... | 110.50 |
| Making a total of..... | $232.82 |
| A saving of..... | $767.18 |

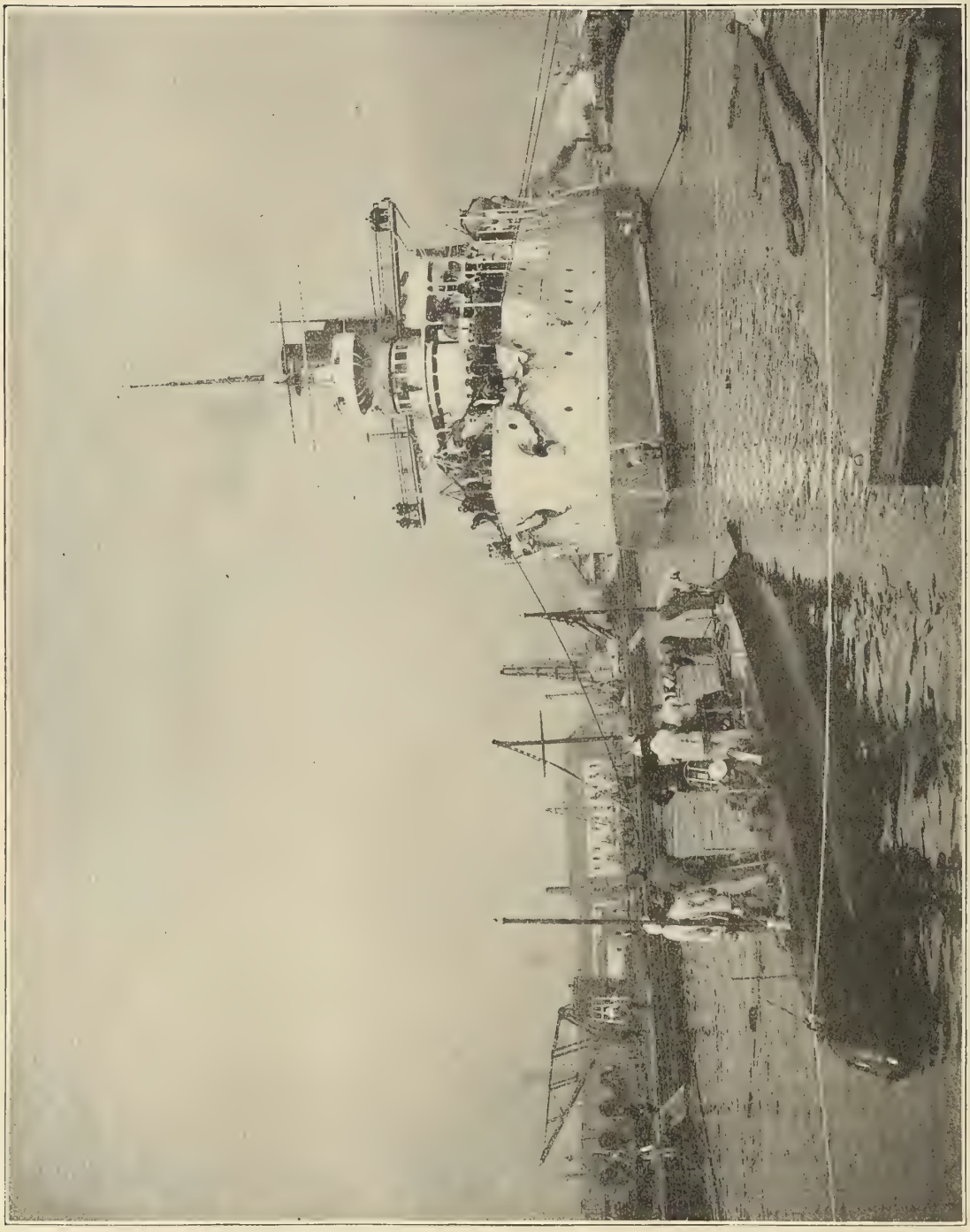
**Russian Battleship "Retvizan."**

The Russian battleship, *Retvizan*, built by the William H. Cramp & Sons Ship and Engine Building Co., and launched on the 23d of October, 1900, has just completed a remarkable speed trial, on which the speed of 18.8 knots is reported to have been averaged for twelve consecutive hours between New York and Boston. The trial had been scheduled to take place after the ship had arrived in Boston waters, but, owing to the extraordinary showing on her way from New York, this trial has been given up.

The *Retvizan* is 374 feet 1 inch long between perpendiculars, 72 feet 2 inches beam, at maximum draft draws 27 feet 3 inches, and displaces 12,700 tons. An armor belt runs from the ram to just abaft the after barbette, varying in thickness from 9 inches amidship to 4 inches at ends. The armored deck is 2 inches thick on the horizontal and 4 inches on the slopes. All armor is of Krup steel, hardened by that firm's latest process. The armament comprises four 12 inch forty caliber guns in the barbettes, the turret being worked by either electricity or hand; twelve 6 inch Q. F. forty-five caliber guns, of which eight are mounted in the central battery, separated by 2 inch bulkheads and four in the structure above the redoubt. The secondary battery consists of eight 3 inch, twenty-four 3 pounder and six 1 pounder Q. F. guns distributed in various parts of the ship. There are also six torpedo tubes, one forward and one aft, two on each beam. Her maximum coal supply of 2,000 tons will give a radius of action 8,350 miles at ten knots, or, 3,000 miles at 18 knots, the latter figure

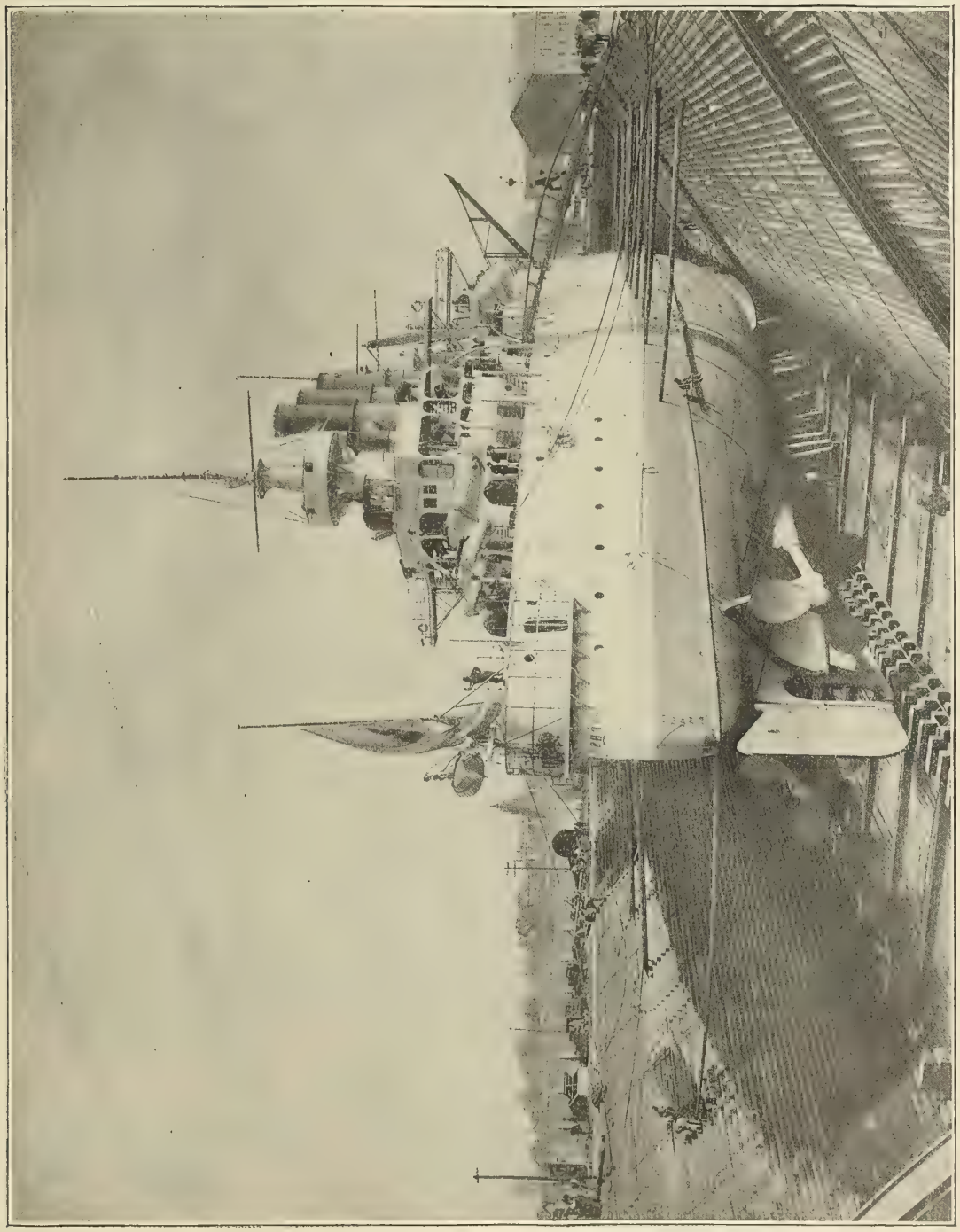


INSTALLING PROPELLER SHAFT ON TORPEDO BOAT SHUBRICK WITHOUT DOCKING.



RUSSIAN BATTLESHIP RETVIZAN ENTERING BROOKLYN NAVY YARD DRY DOCK NO. 3, WITH HOLLAND SUBMARINE TORPEDO BOAT IN FOREGROUND.

(Copyright, 1901, by E. Muller, Brooklyn, N. Y.)



RUSSIAN BATTLESHIP RETVIZAN IN DRY DOCK NO. 3, BROOKLYN NAVY YARD, PREPARATORY TO RUNNING HER TRIAL TRIP ON WHICH THE EXCEPTIONAL SPEED OF 18.8 KNOTS WAS MAINTAINED.

(Copyright, 1901, by E. Muller, Brooklyn, N. Y.)

being the contract speed. There are two sets of triple expansion engines, designed to indicate 16,000 horse power while running at 126 revolutions. Steam is supplied by 24 Niclausse water tube boilers.

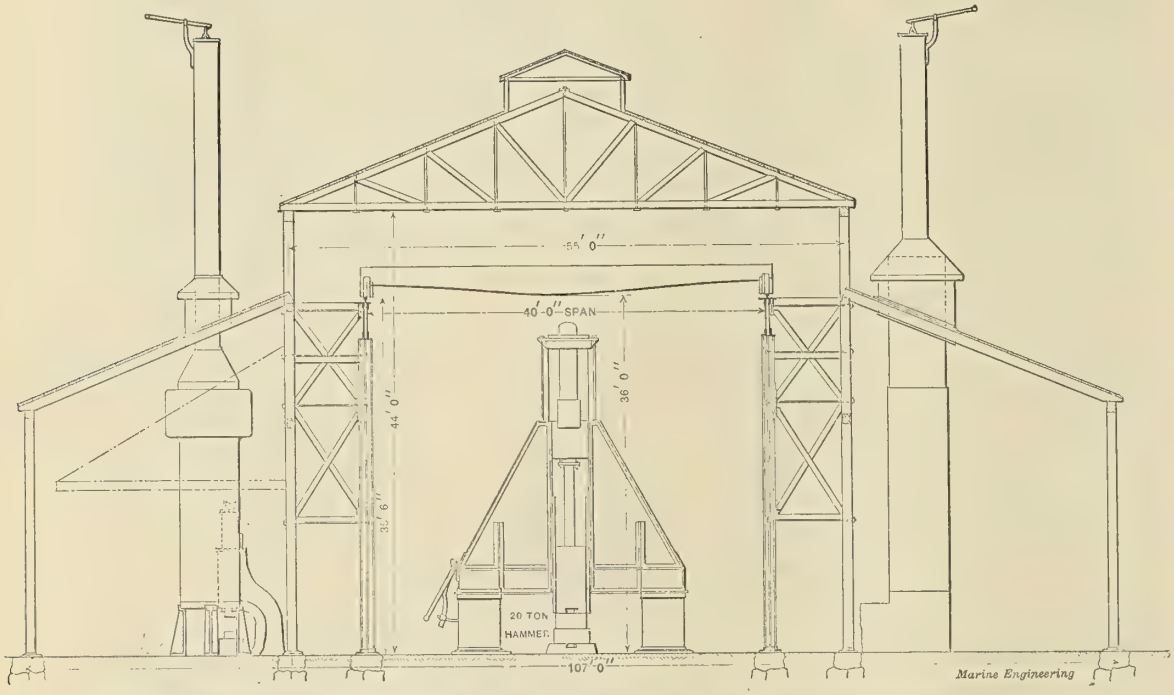
On her way from Philadelphia, the *Retvizan* was brought to the Brooklyn Navy Yard and docked in Dry Dock No. 3 for having her hull painted below water line. One view here shown was taken while the ship was being moored previous to the docking.

**Algiers Dry Dock.**—The floating dry dock built by the Maryland Steel Company for the Navy Yard at Algiers, La., is being towed from the shipyard at Sparrow's Point, Md., to its destination by the steamer *Orion* and a seagoing tug. This dock was fully described in Marine Engineering, of February, 1900,

## FORGE DEPARTMENT OF THE FORE RIVER SHIP AND ENGINE COMPANY, QUINCY, MASS.

The extent to which forgings enter into the construction of the machinery of merchant and war vessels, is a sufficient indication of the important relation which the source of supply of that produce bears to the modern ship building plant. Even with efficient methods, the cost of forgings is relatively high, and the first cost and fixed charges incident to the installment and operation of a forge department have been largely responsible for the omission of such a department from the shipyards of the United States.

The source of supply having thus been limited to a very few of the larger steel works, the position of the shipbuilder has been one of dependence, and the im-




CROSS SECTION OF FORGE SHOP AT THE FORE RIVER SHIP AND ENGINE COMPANY.

**Superposed Turrets.**—There now seems to be very little doubt that the question of superposed turrets for battleships has been finally and definitely settled as far as this country is concerned. The recent action of the Board of Construction in opposing this style of turret is conclusive as far as it goes, but from an inside source we learn that there has been a great change of opinion among officers of the Navy, and now a large majority are strongly opposed to the type. Many officers who have been strong advocates of the superposed turrets and who are not inclined to say in so many words that the type is wrong, are now willing to state that battleships of the *Alabama* class are certainly better than those of the *Kearsarge*, which are fitted with the superposed turret. It is a significant fact that the officers of the Ordnance Bureau this year opposed the type, whereas hitherto that bureau had been strongly in support of it.—*Army and Navy Journal.*

possibility of securing prompt deliveries has seriously delayed the progress of important work.

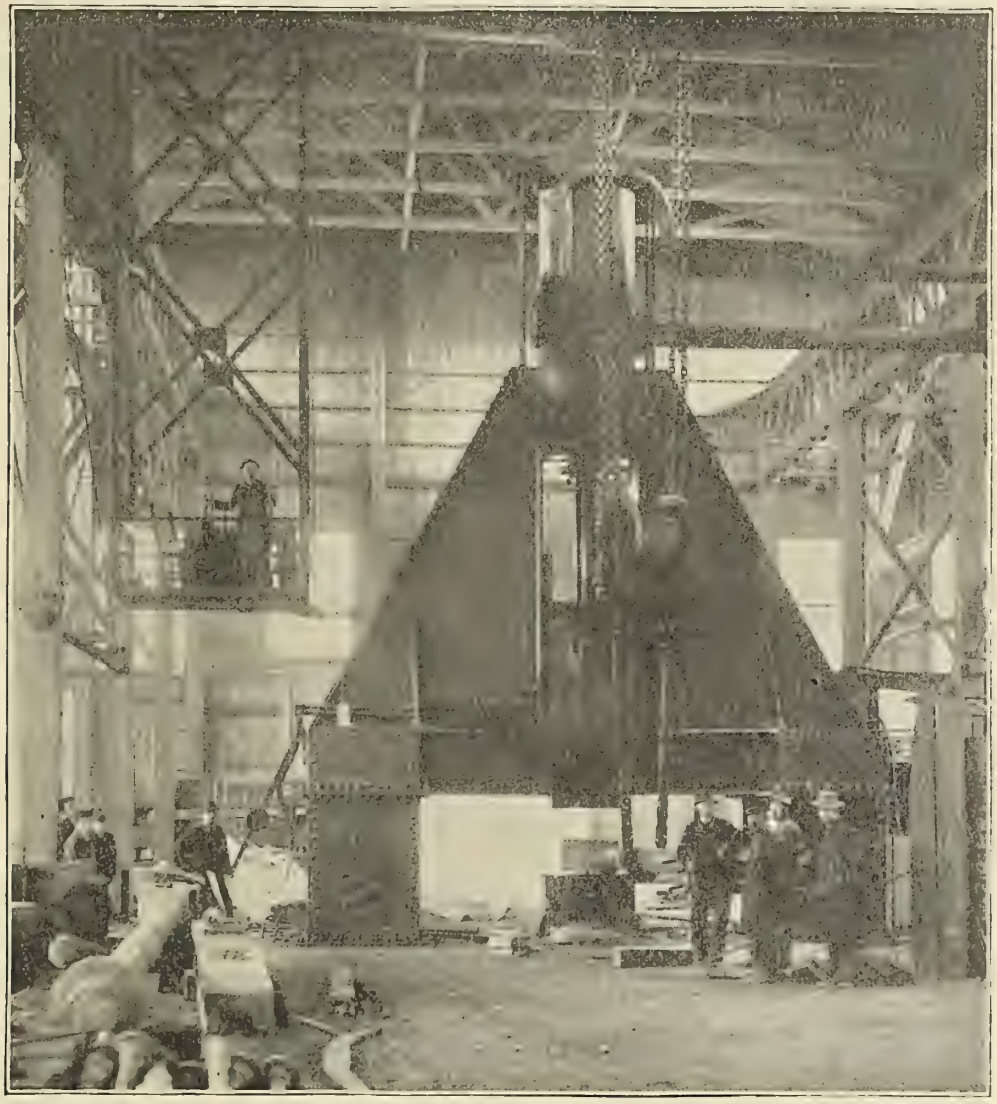
In view of the above, it is gratifying to be able to present in these columns a description, together with illustrations, of a forge department which is exceptional not only as regards the excellence of its facilities, but also from the fact that it is, so far as we are aware, the only forge department operated by a shipbuilding company and capable of turning out heavy crank shafts and all other forgings required in the construction of large merchant steamers and battleships.

The accompanying outline drawings show the general construction and arrangement of the building, which is 107 feet wide and 200 feet long, center to center of posts. The side walls of the buildings are removable, giving free access to air during the summer months, and a spur from the yard railway system, not shown on the plan, enters the building through

the center doorway at the end opposite to that occupied by the large hammer. The girders for the crane track extend the entire length of the building, 40 feet center to center, and are supported by a double line of posts at each side, the latter being thoroughly braced.

The overhead crane service consists of a 150,000 pound electric crane, supplemented by one of 50,000 pounds capacity. The crane operators are stationed on platforms suspended at some distance below the cranes and by means of the operating mechanism are given complete control of all movements of the forgings, including that of rotations either within the furnace or under the hammer. A series of small jib cranes are installed in the wings of the building, thus serving the smaller hammers that are located without the field covered by the larger cranes.

Eight steam hammers varying in power from 40,000 pounds to 600 pounds are now installed, and their locations and capacities are noted on the plan, the figures denoting the weights of the falling parts. The accompanying engraving is reproduced from a photograph of the large hammer, and it may be added that there is but one other hammer of equal power in operation in this country. It has ample capacity for making even the heaviest forgings required in shipbuilding and in engine construction.



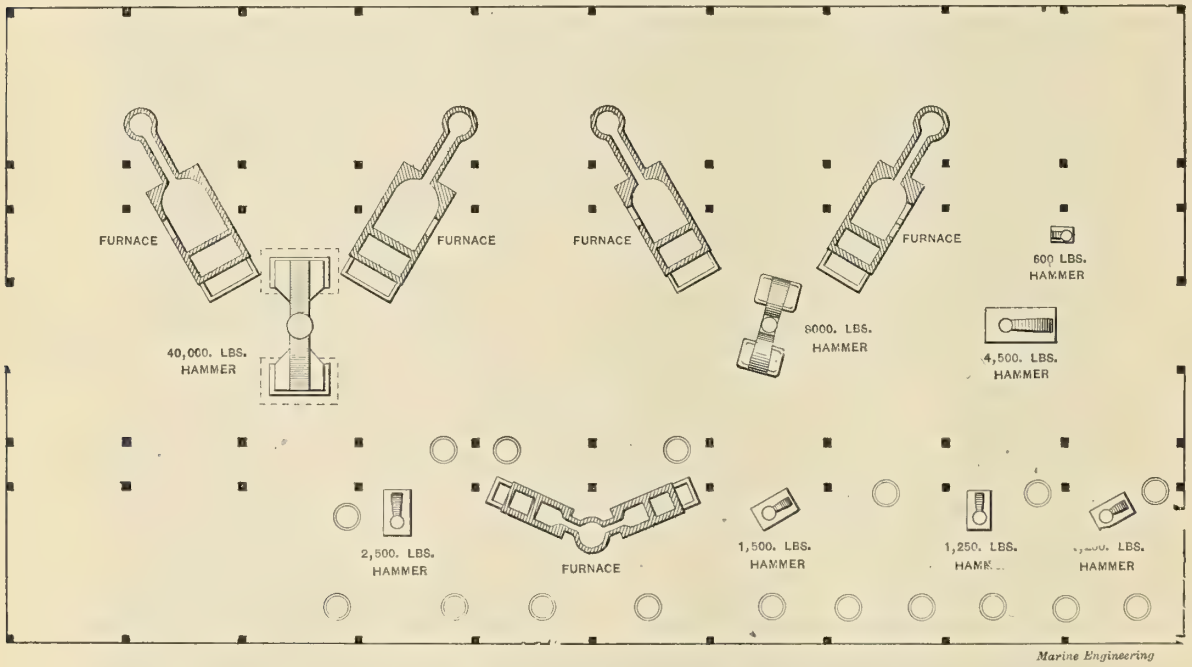
TWENTY TON STEAM HAMMER AT THE WORKS OF THE FORE RIVER SHIP AND ENGINE COMPANY.

The heating furnaces, six in number, are so arranged that ingots and forgings can easily be transferred to and from the hammers, and they are provided with opposite doors through which long forgings may extend. Coal is used as fuel, and a double equipment of direct connected blowers furnishes the blast required for the furnaces and for the forge fires, seventeen of which are shown in various locations. Steam for the hammers is generated in five 72 inch vertical tubular boilers, two being 16 feet high, two 20 feet high and one 21 feet high, the latter being lo-

cated at the two smaller furnaces. The economy of this arrangement, which utilizes the waste heat from the furnaces for generating steam for the hammers, is evident.

Intimately connected with the forge department and rapidly approaching completion, is the annealing plant, a department distinct in itself, yet absolutely necessary in undertaking the production of high grade forgings. This annealing equipment will be described and illustrated in a future article, but for the present it will suffice to say that exceedingly novel designs insuring high efficiency are now being carried out, and the plant will be amply capable of oil tempering and annealing, while suspended vertically, shafts 50 feet long and weighing 25 tons.

Referring again to the question of supply and demand alluded to above, it is an interesting fact that




GROUND PLAN OF FORGE SHOP AT THE FORE RIVER SHIP AND ENGINE COMPANY.

although the Fore River Ship and Engine Company is busily engaged in turning out the forgings for the battleships *Rhode Island* and *New Jersey* and the cruiser *Des Moines*, for which they have contracts, yet they have been able, owing to the large capacity of this plant, to take advantage of the demand for additional productive facilities in this line of work, and to supply rough and machined forgings to other shipbuilders.

**Monthly Shipbuilding Returns.**—The Bureau of Navigation reports 139 vessels of 20,065 gross tons built in the United States and officially numbered during the month of September, 1901.

**Steamship Main.**— The North German Lloyd steamship, *Main*, which was burned in the great Hoboken fire, and was afterwards repaired by the Newport News Shipbuilding and Dry Dock Company, has been delivered to the owners practically a new ship. It is stated that the repairs amounted to $1,000,000.

**The Action of Zinc in Preventing Corrosion.**

In United States Consul Benjamin H. Ridgley's report from Malagar is given the following translation of a Madrid technical paper:

"The use of zinc to prevent the oxidation of iron and the incrustation in steam boilers has greatly increased during recent years. Heretofore, zinc has been employed for this purpose only in the shape of raw pigs, but after many experiments made by the society of 'Mines et Fonderies de Zinc de la Vieille Montagne,' which have since been confirmed by the British Admiralty, by the national French marine, and many great maritime companies, it has been established that compressed laminated zinc made in the form of thick plates for application as an inside boiler lining is greatly superior to the old method. In fact, the galvanic current developed transforms the pig of raw zinc into a more porous substance, in which the metallic molecules are isolated one from the other by the corrosion which is quickly produced, resulting in this, that the intimate metallic current, which causes the generation of the electric current, is eliminated. Compressed laminated zinc, on the contrary, resists the spongy internal corrosion, as it corrodes only on the surface, thus being very slowly consumed and being capable of conducting the current as long as a metallic nucleus remains. The application of the laminated plates is very simple. They are applied to the walls of the boilers by means of strips and are so distributed that the galvanic action is exercised in an even way, when possible, over the entire surface of the iron. When oxidation is produced in any part of the boiler, it is because the nearest zinc plate is too far away. By this employment of pressed zinc the incrustation of the boilers is avoided, and at small cost."

## LAUNCHES.

**Torpedo Boat Nicholson.**—On September 23 the United States torpedo boat *Nicholson* was launched at Lewis Nixon's shipyard, Elizabethport, N. J. The *Nicholson* is 174 feet 6 inches long on water line, beam extreme 17 feet, displacement 174 tons. She is to have two sets of triple expansion engines and Normand boilers.

**Ship William P. Frye.**— There was recently launched from the yard of Arthur Sewall & Company the four masted steel ship, *William P. Frye*. She is 332 feet long, 45 feet beam, 26 feet deep. A new arrangement of deck houses has been carried out on the ship; in place of the usual 'midship and forward deck houses, the *Frye* will have a bridge deck 'midship 68 feet long, divided into the several necessary compartments.

**Steamer W. S. Mack.**—A steel steamer, *William S. Mack*, was recently launched by the Lorain yard of the American Shipbuilding Company. This steamer is for freight service on the lakes, and will carry about 4,500 tons. She is 366 feet in length over all, 346 feet keel, 48 feet beam and 28 feet deep. The engines have cylinders 20, 33½ and 55 inches in diameter, by 30 inches stroke. Steam will be furnished at 175 pounds by two Scotch boilers 12 feet 10 inches in diameter, 13 feet long.

**Torpedo Boat Wilkes.**—The United States torpedo boat *Wilkes* was successfully launched at Morris Heights on September 28, from the shipyard of the Gas Engine & Power Co., and Charles L. Seabury & Company. She is a sister ship to the *Bailey*, and is 175 feet long over all, 17 feet 7 inches broad, and 165 tons displacement. The two sets of triple expansion engines, designed to indicate 3,000 horse power, are to give her a speed of 26 1-2 knots. Three Seabury boilers supply steam at 250 pounds pressure.

**Ferry Steamer Algoma.**—The steel ferry steamer built for the Ste. Marie Ferry Co. was recently launched from the yard of the Polson Iron Works, Toronto (Ont.), Canada. She was christened *Algoma*. The vessel is of the three-deck type and will accommodate 600 passengers. The principal dimensions of the *Algoma* are as follows: Length, 104 feet; beam of hull, 26 feet; beam over guards, 33 feet, and draft, 10 feet. She is fitted with a compound jet condensing engine with cylinders 18-inch and 36-inch diameter and 24-inch stroke. There will be a Scotch boiler 11 feet in diameter and 12 feet long, built for a working pressure of 160 pounds.

**The Cruiser Cleveland.**—On September 28 the United States cruiser *Cleveland*, the first of her class of six, was launched from the yard of the Bath Iron Works, of Bath, Me. Her principal dimensions are as follows: Length on water line, 292 feet; length over all, 308 feet; beam extreme, 44 feet; draft (mean), 15 feet 9 inches; corresponding displacement, with 2-3 stores, 3,200 tons. She is of the composite type with a sheathing of Georgia pine below the water line. The twin screw, vertical, triple expansion engines are to develop 4,700 indicated horse power on trial, and are expected to drive the ship at the speed of 16.5 knots. There are six water tube boilers constructed for a working pressure of 275 pounds, with a total grate surface of 300 square feet, and total heating surface of about 13,000 square feet.

**Submarine Boat Porpoise.**—The Holland submarine torpedo boat *Porpoise* was launched at Lewis Nixon's yard, Elizabethport, N. J., on September 23. She is 63 feet long, 12 feet beam, and will be propelled by engines of 160 horse power.

**Minnetonka.**—The steamer *Minnetonka*, owned by a syndicate represented by Charles E. and W. F. Peck, of New York, was successfully launched from the Cleveland yards of the American Shipbuilding Company. The general dimensions are as follows: Length over all, 450 feet; length between perpendiculars, 430 feet; beam, 48 feet; depth, 35 feet. The *Minnetonka* will engage in transatlantic service, and her capacity on 25 feet draft will be 8,000 tons dead weight.

**Steamer Chicago.**—The Lake steamer *Chicago*, belonging to the Western Transit Company, was successfully launched from the yard of the Buffalo Dry Dock Company on September 28. She is a double deck passenger and freight steamer, with a lower deck forward and aft. All the deck houses are of steel. Her dimensions are as follows: Length over all, 343 feet; length between perpendiculars, 325 feet; beam, moulded, 44 feet; depth, moulded, 28 feet. The machinery consists of a quadruple expansion engine with cylinders 19, 27 1-2, 40 and 58 inches in diameter respectively, by 42 inches stroke. There are three Scotch boilers 11 feet 6 inches long, and the working pressure will be 210 pounds. This steamer will run between Chicago and Buffalo with occasional trips to Duluth.

**S. S. Kotsu-Maru.**—On the 28th August the Ishikawajima Shipbuilding and Engineering Co., Ltd., of Tokyo, Japan, launched from their shipbuilding yard at Uraga, near Yokosuka, a handsomely modeled steel screw steamer, built to the order of Mr. Shichihei Oiye, of Osaka, for the Vladivostock line. The vessel which is named *Kotsu-Maru*, which means *communication*, is of the spar decked type built under special survey of class 100 A1. at Lloyds, and also in accordance with the Japanese Shipbuilding Encouragement Act. The vessel is of the following dimensions: Length over all over, 251 feet; between perpendiculars, 240 feet; breadth moulded, 34 feet; depth moulded 22 feet, having a displacement of 2,800 tons and a gross register tonnage of 1,550 tons. The hull is fitted with double bottom for water ballast on the cellular principle fore and aft, and also in fore and aft peak tanks. There are steam winches, a steam steering gear, steam windlass, and a complete electric lighting plant. The engines, also constructed by the company at their engine shop in Tokyo, are of the triple expansion type of 1,150 indicated horse power, having cylinders 18 1-2, 30 and 52 inches in diameter and a stroke of 36 inches, steam being supplied from two large single ended steel boilers working at 200 pounds pressure and fitted with evaporators, etc. The vessel will be rigged as a two masted fore and aft schooner. As the vessel left the ways she was named by Baroness Shibusawa, wife of Baron Eiichi Shibusawa, the president of the company.

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THE condition of the engineering branch of the navy is one which demands the immediate and serious attention both of Congress and of the administrative officers of the Navy Department.

The features of the recent personnel bill relating to the provision of officers for engineering duty in the navy have always been considered in large measure experimental, and it is now quite generally realized that as it has been administered it has in many ways fallen far short of realizing what its friends and promoters hoped. One of the fundamental features of the bill was an increase in the number of officers capable of doing engineers' duty through the assignment to such duty of the younger deck officers. It was realized that the engineering branch needed strengthening, that the number of officers available or capable of such duty should be increased, and it was proposed to bring about such end by the assignment of the younger officers to duty in the engineers' department, the number of officers so assigned and the length of their assignment being intended to provide a sufficient number of adequately trained officers for all supervisory duty in this department. As a matter of fact, however, such officers have not been assigned, or, at least, in very inadequate numbers, and the consequence is that as the former engineer corps is gradually being reduced by death and retirement, the number of highly trained engineers in the navy is continually on the decrease, while the demands are correspondingly on the increase. Especially is this true in the lower grades, which are continually being depleted by promotions to higher grades.

The excuse is made that more officers are not assigned to engineer's duty because they cannot be spared from deck duty. This phase of the situation is the result of a serious shortage in the lowest grade of officer, that of ensign.

When the navy personnel and reorganization bill was passed a few years ago, provision was made for suitable numbers of officers in the various grades and for insuring a certain rate of flow from the lower to the upper grades. This would naturally call for an adequate supply at the bottom, and to meet this need the committee recommended that the course for naval cadets be made four years instead of six, *i. e.*, that the various appointments should become vacant every four years instead of every six, as was then the case.

This would have insured an increase of about 50 per cent in the output of the Naval Academy, and would have been presumably an adequate supply for all needs. This feature, however, was not adopted by Congress and the source of supply was left as before, with greatly increased demands in the higher ranks. The natural result is that in the course of a few years the lowest grade, that of ensign, has fallen 119 short of the full quota of 245 authorized by law. This grade has been continuously drawn upon to make up for the wastage in the upper grades, and while they are full its own supply has been quite inadequate to the demands, and in consequence it has but about half the number authorized by law.

The Bureau of Navigation, which has direct charge of the assignments of officers, is supposed, in large measure, to be the judge of the relative needs of the two branches of the service, and the policy adopted shows that in the judgment of this Bureau the need of officers for deck duty and the desirability of their being trained in such duty have been considered paramount, while the need for officers in the engineers' department and the desirability of their being

trained in these duties have been considered secondary.

This is, of course, a question of policy, but it is one of the most tremendous importance to the engineering profession, and to the nation at large, as interested, and in some measure dependent on the fitness of the navy to do the work which may be assigned to it. The lessons to be drawn from the Spanish-American war are too plain to be ignored. A chain is no stronger than its weakest link. On the Spanish ships the engineers' division was, perhaps, the weakest link. We refuse to believe that the day can ever come when it can be said that the engineering branch of the United States Navy is its weakest link. Unless some attention, however, is given to the matter, and unless some steps are taken which shall make good the inevitable loss through natural wastage, it is hard to see what other fate is in store for this branch of the service.

We may therefore formulate briefly our conclusions as follows:

(1) The personnel bill as passed, and as it has been actually administered, has proven disastrous to the engineering branch of the navy.

(2) It is claimed, and presumably with good reason, that this is in large measure due to the failure of Congress to provide for the training of officers sufficient to fill the positions which it had created.

(3) It is further claimed by those interested in the engineering branch that while the administration has labored under difficulties it has not done all that might have been done, nor all that the situation demanded.

(4) It follows that, having due regard for the necessities of the engineering branch of the service, either entirely new legislation is required or modifications in the present system.

(5) The friends of the present system claim that it has not yet had a fair trial.

(6) If, therefore, it is to be given a further trial, action is absolutely necessary, and it should be taken without delay. This should include such legislation (providing, among other things, an adequate supply of younger officers) as will give every opportunity for the scheme to show its possibilities, and, together with this, there should be a somewhat keener appreciation by the administrative officers of the Navy Department of the needs of the engineering branch of the service, and the laws and regulations must be administered in the light of such heightened appreciation.

Whether a result thoroughly satisfactory to the engineering needs of the naval service can be worked out of the present system by any minor legislative modifications or by any administration of such a scheme, no matter how friendly, remains perhaps for the future to show. It is sure that the scheme is so far not a success, and it may be said with equal certainty that it has not had a fair trial. Let a fair trial therefore be given it, let its warmest advocates have no cause for urging lack of opportunity, and then, if satisfactory results are still lacking, let it be swept away and replaced with something which may be depended on to safeguard the engineering interests of the naval service.

WE publish on another page some observations relating to the strength of propeller shafts, coupled with an invitation to those interested to aid in the discussion of this most important topic. The undue percentage of marine casualties due to the breakage of propeller shafts has pointed to this feature of the propelling machinery as somewhat lacking in the margin of strength needed to safely withstand the irregular and unforeseen stresses to which it is subject. It is easy, of course, to provide a shaft of sufficient strength for the normal turning moment of the engine, and actual shafts as designed are readily shown to have a large factor of safety relative to such loads. It is rather in the unforeseen, irregular and accidental stresses that the danger lies, and only experience can indicate the proper margin for such contingencies. From the chief causes of these irregular stresses, as elsewhere noted, it is clear that the problem is one which cannot be solved by any appeal to abstract mathematics or mechanics, but rather by experience under the actual conditions involved. It is for this reason that we ask the aid of those who have had such experience. In no other way can such a problem be approached with any prospects of reaching a successful solution, and we therefore ask that it be given for the benefit of others and as an aid in throwing light on this topic, either as regards the design for suitable strength or the mode of construction and fitting which may have proven themselves the best suited to preserve the shaft intact against corrosion and to withstand the severe duty it is called upon to perform.

## THE CONTEST FOR THE PRIZES.

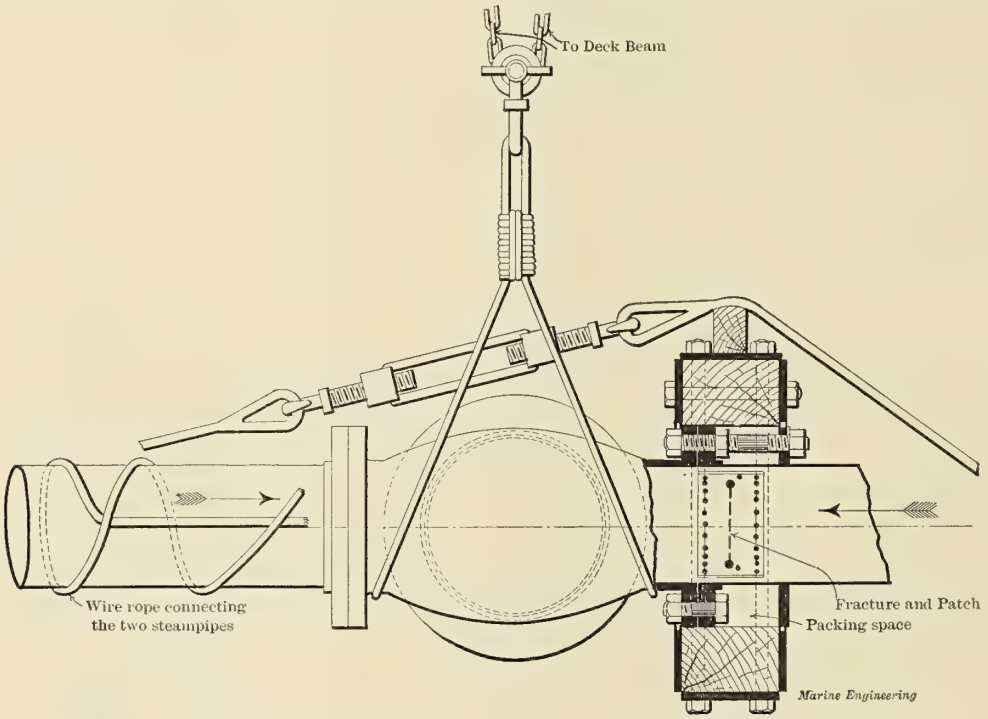
*All articles intended for competition for the two prizes of $15 and $10 each, mentioned in our advertising pages, must be sent in promptly, as the contest will close on December 31.*

*All articles published will be paid for at the regular rates. The best and the next best will draw the prizes in addition.*

### Repairing a Burst Main Steam Pipe.

We were light on our voyage from Manila to San Francisco, and after leaving Nagasaki, at which port we put in to coal, we experienced heavy weather. The triple expansion engines were supplied with steam from two double ended Scotch boilers, working at 150 pounds per square inch. A copper pipe, 7-inch bore, was led from each boiler, the two pipes being jointed to a brass tee piece, from which a copper pipe, 10 1-2-inch bore, was led, supplying steam to the main engines. A few days after leaving Nagasaki we noticed a slight escape of steam from the feeder from the starboard boiler, and on examination found a fracture extending circumferentially for a length of 6 inches at a distance of about 1 inch from the flange by which the pipe was jointed to the tee piece. We soon had the pipe adrift, bolted a patch inside over the crack and replaced it; but in forty-eight hours we again turned to, as the patch had given out, and the fracture was evidently extending. We then tried another method, of which I give a description and sketch. We formed a packing space round the pipe at the fracture by bolting two halves of a wood stuffing box over the flanges. Every second bolt of the joint was carried out beyond the stuffing box to form the gland stud. The gland was packed with pieces of old circulating pump valves, Tuck's packing, etc., and the gland, consisting of a flat plate in halves—screwed home. We turned on steam very gradually and found the plan very successful for a few days, but the continual racing of the engines caused a great amount of vibration along the pipe, and it became necessary to supplement our second plan. We replaced the first stuffing box with a similar one, packing it as before. Then, from a convenient deck beam, we supported the weight of the pipes and tee piece, and, to minimize as far as possible the tendency of the pipe to expand in an athwartship direction and thus increase the fracture, we secured the two pipes with wire rope connected by a turnbuckle, which enabled us to draw them taut. This arrangement carried us along under full steam for ten days, at the end of which time the packing gave out, and on emptying the stuffing box we found that the escaping steam had worn a hole 1 inch in diameter in the copper pipe and had worked nearly through the wood stuffing box. Being now within two days of port, it was decided to go on under one boiler, which we accordingly did by putting a blind flange at the joint of the tee piece and pipe. The steering gear and auxiliary machinery were still worked from the starboard boiler, and we reached San Francisco without further mishap.

ANDREW WESTWATER.




SHOWING METHOD OF REPAIRING A BURST MAIN STEAM PIPE.

### A Morning Conference Between the Inspector and Superintendent.

"Good morning, Mr. Inspector. More trouble for us to-day, I suppose," said the Superintendent of the Unger Rolling Mills, as I was about to look over

some test pieces rolled the evening before. "Let us talk the matter over," said I, "and learn what you call trouble before I answer you.

"You call it trouble, I suppose, because I will not allow your man on the testing machine, who suspects the material for those boiler shells will fall below 63,000-pounds tensile strength, to run the machine at a speed not exceeding four inches per minute, or when his preliminary test has shown him the tensile strength to be all right and the elongation deficient, to reduce the speed of the machine in order to get all of the stretch out of the material possible; or when we make a quench bending test to run the temperature of the water above 82 degrees and hold the test piece in the dark or under the shadow of the forge so it will appear cherry red at a lower temperature than it would if held in the open; and because I insist on turning the plates over and looking at both sides, you say I make you trouble."

"But the other inspectors do not require the plates to be turned over, but look at the tops of them while on the floor, and we raise them with the crane and they then look at the under side," said the Superintendent.

"My experience has been that many defects are on the under side, and they cannot be seen by looking up at them while in the shadow and, furthermore, a suspended plate is dangerous to walk under. You seem to forget the day we tested those heavy shell plates, when a rejection would have cost you considerable money, to say nothing of your peace of mind, and you insisted on pressing the test piece down all at once instead of gradually, and when it broke I allowed you to make another test and asked you to drive it down gradually with the steam hammer, the result being a success. My theory was that the molecules were thus allowed time to adjust themselves between the blows, while under the press they were not. I have also noticed that when you have suspected from the analysis that the material would fall short in tensile strength you have cold rolled it in order to increase its strength and have done the reverse when you imagined the elongation would fall below the requirements. You seem to forget the time two large slabs were cobbled so badly they could not be passed through the rolls and the whole mill was looking around for the cause, and I suggested it was caused by screwing down on the rolls on the back pass, and upon investigation it proved to be true, and you asked how a marine engineer knew anything about rolling mills, and I told you our mills do nothing but roll. You thought I was giving you trouble when I rejected those 2 1-4-inch boiler braces which were required to show a tensile strength of not less than 63,000 pounds per square inch of section and an elongation of not less than 24 per cent in eight inches. The material was so large you could not pull a full section of it in your testing machine, so you turned the test pieces down much smaller than there was any necessity for in order to have the section measure one square inch. Of course you were not doing justice to the material, and it did not come up to the requirements. I saw your trouble and asked you to have the test pieces turned as large as the testing machine would pull; you did so, and the material passed with a good margin. This would indicate that rolled rods are of lower tensile strength at the center than at the circumference. In other words, if a rolled rod is turned down and pulled until broken it will not show as high a tensile strength as it would if the original section had been pulled. A rod if cold rolled will have its tensile strength increased within certain limits, but at the same time the elongation will be reduced. Or the elongation may be increased by annealing, but it will reduce the tensile strength.

"Now, Mr. Superintendent, of course these facts are not new to you, but let me tell you it has been the high requirements and close inspection, especially for marine work, which has placed American steel so far ahead of all others, and it is this fact which keeps this mill going and secures for you the salary which a foreigner considers enormous."

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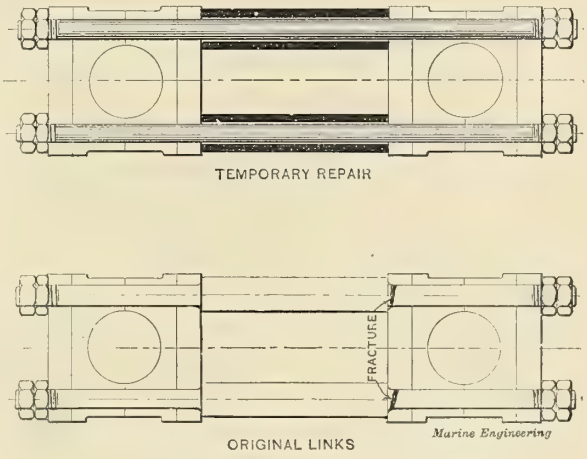
### Repair to the Pump Links.

*Editor of* MARINE ENGINEERING:

Following is a description and sketch of a temporary repair made at sea on board the British tramp steamer *C*——. The breakdown occurred while I was serving as fourth engineer on a voyage from New York to South Africa.




SHOWING BROKEN AND REPAIRED PUMP LINKS.

The air, circulating, feed, and bilge pumps were all connected to a common crosshead, which was worked by means of the usual levers and links from the low pressure engine. We had had considerable trouble with the forward pump links on account of the nuts slacking back, and finally the bolts fractured at the shoulder. We immediately stopped and in a couple of hours effected a strong repair in the following manner. Two steel rods of the required diameter and length were threaded and nuts fitted. Two pieces of iron pipe were cut to the required length to form distance pieces, and the whole fitted together as shown in the accompanying sketch. We ran for seven days with this arrangement, permanent repairs being made on reaching port. ANDREW WESTWATER.

San Francisco.

### Stopping a Blow off.

*Editor of* Marine Engineering:

I have been very much interested in the series of articles on accidents and mishaps running in your valuable magazine, and will endeavor to contribute an account of a small accident and its remedy which came within my experience. A number of years ago while employed as assistant engineer on an old ship running fruit to New York the following mishap occurred:

The machinery of the ship consisted of an old single engine 42 inches square, with all pumps attached and a boiler of the firebox return tubular type. As we had neither evaporator nor tanks and our steam pressure was low, we used salt water.

We had heavy weather all the trip and were about off Hatteras bound to New York. I had just gone on watch, and finding the density of the water in the boiler too great, started to blow off a little. On attempting to close the blow cock it stuck fast and could not be shut, and as there was no valve on the ship's side, we were in a bad fix—a gale of wind blowing, sea running high and blow cock wide open, the water blowing out faster than it could be fed in. To stop the engine meant to fall off into the trough of the sea and be swamped, and it was only a question of time when she would stop herself if that blow off was not closed.

Realizing the necessity of prompt action I looked around and my eyes fell on the coal hammer and a heavy sledge. Calling the fireman to hold his hammer to one side of the blow off pipe, which was copper, I took the sledge and began to flatten the pipe. Fortunately the brazing held and we succeeded in hammering the pipe out flat, thereby stopping the water. An old rivet was afterward found wedged in the blow cock and preventing it from closing. Off Shore.

### Repairing a Broken Shaft.

*Editor of* Marine Engineering:

I send you herewith report of the repair to the broken propeller shaft on the *Athena*, which I have saved for future use in case a similar accident should occur on my ship, and I would recommend to young engineers that they preserve all such information as is now appearing in your Prize Contributions as a valuable addition to their dictionary of useful information.

Subscriber.

"About mid-way between St. Helena and Tristan d'Acunha, in the month of July, 1900, the *Athena* (Captain W. Jones) broke her propeller shaft when bound for Bahia Banca from Algoa Bay, and before the repairs were effected she had drifted north, and on making for port arrived at Bahia, San Salvador, considerably out of their course.

"The shaft broke just as darkness was setting in on July 9th, and on examination it was found that the fracture had occurred in the stern tube, breaking it also, and exposing the damaged shaft in the last frame of the after peak, so that it seemed almost hopeless to repair it.

"The ship was provisioned for five months on starting the voyage. Of these, three months had expired, and it was decided to reduce the rations to one-third allowance, while the engineers engaged themselves to try and bind the broken portions of the shaft together, and during the time—thirty-five days—thus occupied, not a sail was sighted.

"The chief engineer, Mr. Shepherd, on considering the best way and means to set to work to repair the damage, found that, owing to the contracted space, only one man could work at a time, while the donkey engine would have to be kept going to pump the water coming through the stern bush. However, the work was agreed upon, and at once commenced and carried out successfully in the following manner: Stanchions were taken from the holds, forged and dressed to form keys and bands; bolts were taken out here and there from the feet of the engine columns to secure the bands, and a sleeve of quarter inch steel plate was made to fit closely to the shaft, every detail of the work being thoroughly done. Meantime the two ends of the broken shaft were examined, keyways were cut into them ready to receive the keys which were being forged to bind the broken portions together, and the stern tube being at the same time cleared away to give sufficient room for the binding sleeve and bands to turn.

"When all the keys were fitted the open fracture was wedged with 1-2-inch and 5-8-inch iron and made solid, and over all and through was run patent metal. The shaft was then sheathed with the sleeve and bound firm.

"After weeks of anxiety and aimless drifting thirty-five miles aft daily, the work was tested and the engines run about half speed, the ship reaching port after about 900 miles steaming and was safely moored in harbor."

### Communication.

*Editor of* Marine Engineering:

I beg to submit the following shipyard menu, and would recommend it to builders as appropriate for launching banquets. Crosshead.

SOUP.

Green Turtle Deck. Goose Neck.

FISH.

Plates. Assorted.

ENTREÉ.

Bullwark Steak, à la mode.

GAME.

Duck, any thickness. Cranes, traveling or stationary.

MEAT.

Broiled Dogs on Toast.

Fricasseed Knuckles. Ram Cutlets.

Curry of Breasthook. Boiled Bulkheads.

Roast Pig Iron. Devil Claws.

EGGS.

Of any Hatching.

DELICACIES.

Cheese Head Screws. Blades of Propellers.

Mixed Pickling.

FRUIT.

Gages. Currents, River and Electric.

NUTS.

Square, Hexagon, Slotted and Butterfly.

DESSERT.

Crow's Nest Pudding.

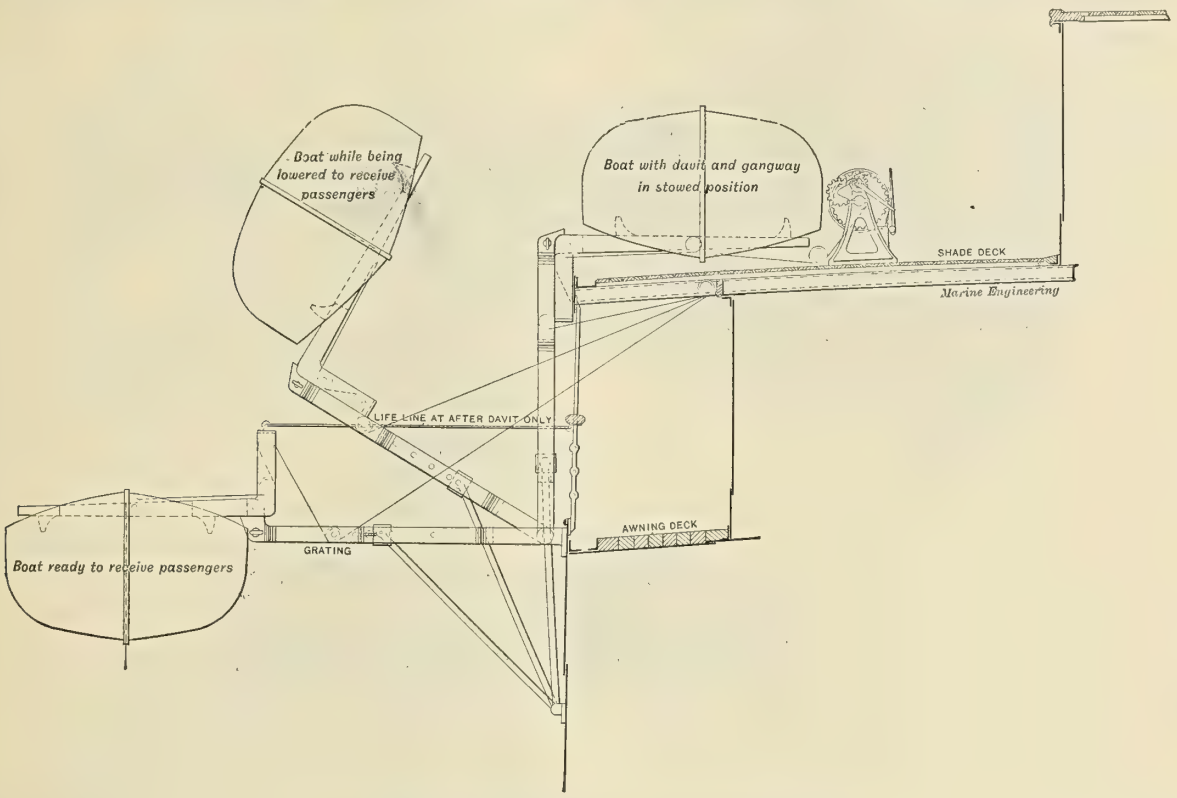
Coffer Dam. Tee Bars.

Note—Pipes and the latest magazines will be found on the ground floor.

## ENGINEERING SPECIALTIES.

### Boat Launching Device.

A new form of apparatus for carrying and launching life boats on vessels is shown in the accompanying engravings. In the sketch the boat is shown in three positions: as it is carried on the vessel, during the operation of lowering, and when lowered to the proper level to take on passengers. When not in use the boat is carried upside down on the shade deck, to that no covers are necessary, and the boat does not collect dirt or water. The boat is carried outside of the davit, which takes the place of the usual cradle. There is but one line to each davit, and when this is made fast, the boat is stowed and no further guys are required to keep it in position when under way. All the oars, spars, stores, etc., required to be carried in the boats are lashed in place. It is claimed for this mechanism that while it is more complicated than the ordinary form of davit, it very much simplifies the operation of getting the boat into the water. The operations for lowering the boat are as follows: (1) Releasing the hand hoisting winch. (2) Pushing the boat overboard and lowering it into outstretched position. (3) Taking on passengers and crew. (4) Lowering into water. (5) Casting off lines, and rowing away from the side of the ship. The boat touches the water at a sufficient distance from the side of the ship to escape the back wash, and to permit the oars being used the instant the boat touches the water. The operations for casting out the boat with ordinary davits are somewhat as follows: (1) Casting off covers. (2) Throwing down outer chock and casting off gripes. (3) Clearing off tackle and hoisting clear of seats. (4) Casting off davit guys. (5) Swinging boat outboard. (6) Guying davits in outboard position. (7) Taking on passengers and crew. (8) Lowering into the water. (9) Casting off lines an pushing away from the side of the ship. As shown in the sketch, the davit, when housed, lies close alongside and outboard of the rail, and when lowered the gratings on the davits form a gangway between the side of the vessel and the boat. It is claimed for this davit that the boats are carried so that there is no necessity of raising them from their seats, and that the boats can be easily launched, no matter how much the ship may be listed, this being accomplished by means of a toggle bolt and a series of holes in the davit, which permits the davit to be stopped when parallel to the water. When the ship is rolling, launching can be effected by choosing a moment when the roll of the ship is towards the side on which the boat is carried. This device has been patented by Wilbur F. Powers, Wilmington, Del.


Boat while being lowered to receive passengers
Boat with davit and gangway in stowed position
SHADE DECK
Marine Engineering
LIFE LINE AT AFTER DAVIT ONLY
AWNING DECK
GRATING
Boat ready to receive passengers

ILLUSTRATING NEW DEVICE FOR LAUNCHING SHIPS' BOATS.

### Foster's Fog Signals.

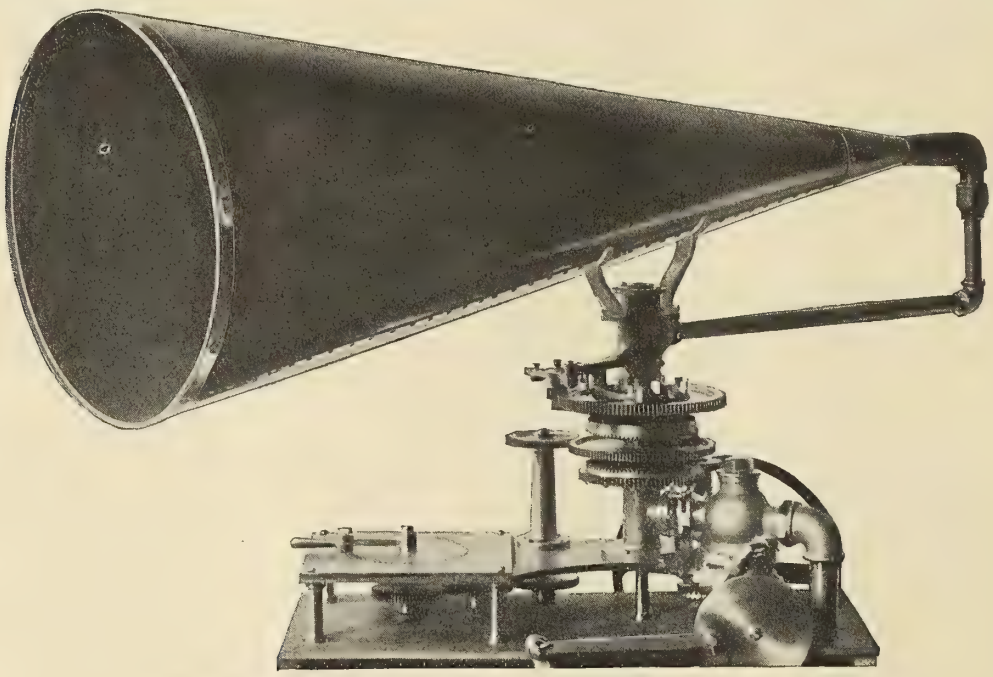
The problem of safety from collision at sea has rightly been divided into three parts: 1st, to prevent the collision; 2d, to save the ship in case of collision; 3d, in case the ship must be abandoned, to save the passengers and crew. Foster's system of fog signalling aims to reach the root of the matter by preventing the collision, and so to make provision for the

second and third parts of the problem unnecesssry. This is accomplished by means of a signalling apparatus which not only warns approaching vessels that they are in close proximity, but enables each to tell the other its exact compass bearing from the other, and also the course it is steering. The great difficulty with sound signals, as distinguished from light signals, is that they cannot be located with accuracy. Nothing is more common than for a vessel to turn out of its course under the impression that a certain signal is several points on the bow, when it is really dead ahead.

Foster's system of fog signalling announces with certainty to any person within hearing, the exact direction from which the warning sounds come.

This is accomplished by the use of a sound director or megaphone, which concentrates and projects various signals first in one direction, and then in another, combined with an apparatus for varying the signal according to the direction to which it is sent. Any passing vessel must hear one of these sounds more clearly than the others, and the signal that it hears most distinctly tells it the exact direction from which the sound comes. The apparatus is in the form of a single automatically revolving megaphone, which turns to each of the eight points of the compass in turn—west, northwest, north, etc., and gives a signal for each point by means of a simple code of long and short blasts.

The form of the apparatus here illustrated is used on board ship, and is so constructed that the megaphone can be easily turned, so as to give the proper signals, no matter how much or how often the vessel changes its course. To accomplish this, a pointer on a dial representing a compass is shifted so as to agree with the course steered. If the vessel's course is W.S.W., for instance, the pointer is simply put on that mark on the dial. As the vessel proceeds upon her course she blows her signals automatically, giving any other vessel which may be in the neighborhood exact information as to her position. As the revolving megaphone in its circuit points toward the bow of the vessel upon which it is placed, it blows a supplementary signal of different character, such as the whistle on the smoke stack, which shows that the megaphone is then pointing directly toward the course which the vessel is steering. If this course signal immediately precedes or follows a compass signal, it gives the vessel's course. If the megaphone signals "east," and the whistle immediately follows, showing that the megaphone is pointed over the bow, the vessel must be east of you, and its course must be a little north of west. When two signals are heard with equal clearness, both louder than any preceding or following ones, the direction of the danger must be midway between the two points which are heard with equal distinctness.



THE HAMILTON-FOSTER FOG SIGNAL FOR INSTALLING ON SHIPBOARD.

Men-of-war use this apparatus to enable the vessels of a squadron to maintain an exact position with relation to one another on the darkest night, without having to show a light of any kind. During blockades a vessel could indicate its position to the commodore at night, and the signals would be quite inaudible on shore as the megaphone would not be pointed that way. A very simple attachment to the signalling apparatus enables vessels to communicate with one another by the Morse code, but the messages sent are inaudible to any vessel but the one toward which the megaphone is directed.

This apparatus was erected at Falkner's Island, on Long Island Sound, and thoroughly tested by a special committee appointed by the Lighthouse Board at Washington. The report of this committee was so favorable that the United States Government im.nedi-

ately purchased the apparatus as it stood, and asked Congress for an appropriation for the erection of similar fog signals at other points. The Canadian Government have also purchased the apparatus, and are erecting a signalling station at Fame Point, in the Gulf of St. Lawrence.

The apparatus is manufactured by the Hamilton-Foster Fog Signal Co., 11 Broadway, New York, U. S. A., and is patented in all maritime countries.

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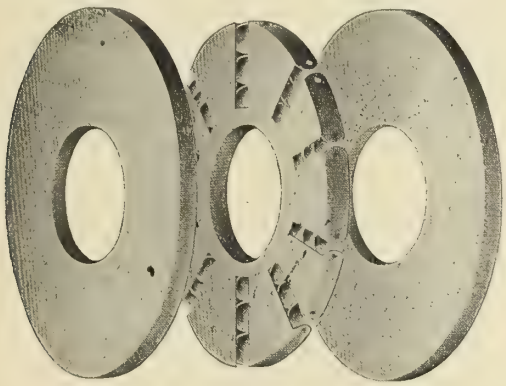
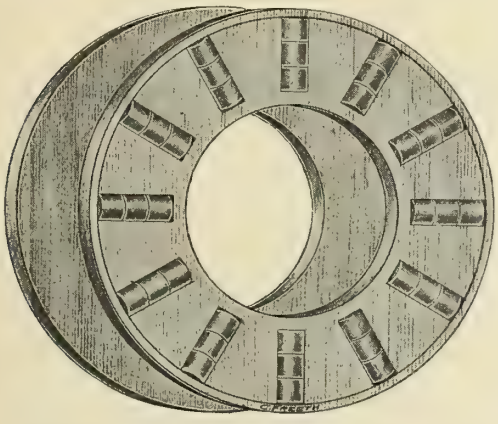
### Standard Roller Thrust Bearings.

The accompanying illustrations show three forms of roller thrust bearings adapted to take up with the minimum amount of friction the thrusts of end or propeller shafts, thereby greatly reducing the power required to drive the shafts.



THE STANDARD BALL END THRUST.

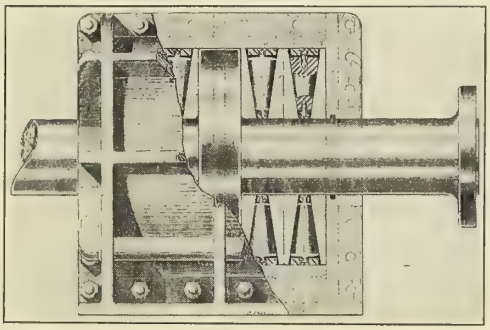
The Standard Ball End Thrust consists of a series of balls radiating from a common center, the balls



THE STANDARD PLAIN ROLLER END THRUST.

being staggered so that no two run in the same track. There is a steel washer on each side of the ball retainer. These washers are thoroughly hardened and ground with great accuracy, and for light work this bearing gives good satisfaction.

The Standard Plain Roller End Thrust is on the same general design as the Standard Ball End Thrust, but it carries straight rollers in small sections which have been found, by experience, will carry several times the load that the Ball End Thrust will of the same size. This bearing gives satisfaction on light loads and also for heavy work. This bearing, theoretically considered, does not appear to be properly constructed as the rollers are straight and run between two flat surfaces. Their short length, however, prevents twisting of the rollers due to the circumference being larger on the outside diameter than it is on the inside diameter, and it has been found by practical experience that these bearings will sustain loads of over 100,000 pounds with satisfaction.



THE STANDARD TAPER ROLLER END THRUST.

The Standard Taper Roller End Thrust consists of conical rollers with metal washers, all parts being accurately ground as well as hardened. The use of conical rollers is old, but in practice it has been found that there is an outward pressure that has a tendency to force the rollers against the retaining ring (or whatever confines them in place), and in a comparatively short time they grind out this portion and ruin the bearing. The construction of this thrust bearing is such that this cannot occur as a ball is countersunk in the end of each roller, which takes up all outward pressure and wear. This bearing is especially adapted for use on propeller shafts, or where there is a very heavy strain. The use of this ball is at the end of the roller; it keeps the rollers in perfect alignment as well as prevents wear of the confining rings.

These three forms of thrust bearing are made by the Roller Bearing Company of Philadelphia, Pa., to whom further inquiries should be addressed.

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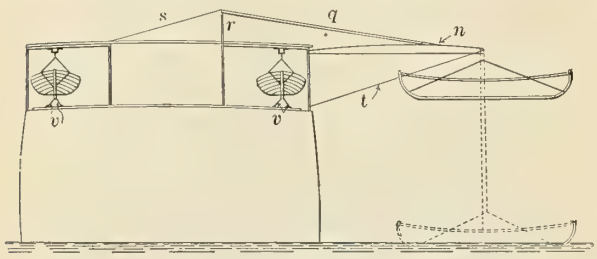
### New Construction of a Boat Launching Apparatus.

In recent years very few inventions have been made in appliances for launching boats from shipyard, whereas numerous and excellent ideas have been developed in improved life-boats, rafts, self-detaching hooks, life preservers in different shapes, etc. However, no ship, no matter how well constructed, engined and manned is proof against accident, and no one knows at what time the ship must be abandoned, and the only means of rescue will be the life boats. Admitting the great value of good life boats and other appurtenances pertaining to means of life saving, the

fact remains that unless the vessel is fitted with an apparatus by means of which the boats can be easily launched under any existing circumstances, the safety of the lives entrusted to the ship is not assured.

Of the many improved boat davits, the most prominent is the Mallory davit, which to a great extent is being adopted both in merchant and naval vessels as superior to the old style swinging davits. Unfortunately even the best system of davits now in use does not fulfil the requirements, as too much labor is




SECTION OF SHIP WITH LAUNCHING APPARATUS.

generally involved in manipulating it and there is too much uncertainty as to its proper working in case of emergency.

3. Boat launching apparatus should preferably be so constructed that any boat can be launched from either side of the vessel.

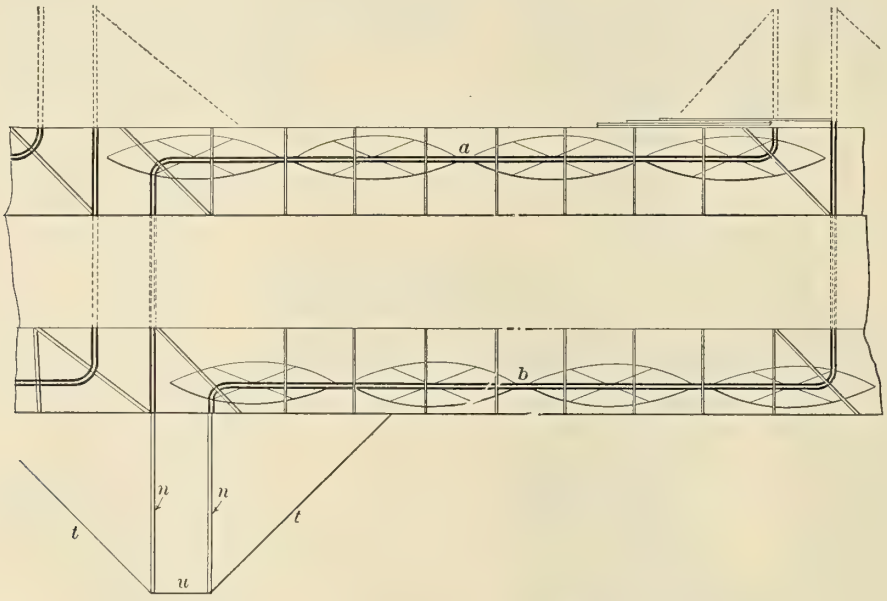
4. Boats must be well clear of the vessel when they reach the water so that oars can be used on both sides of the boats.

5. The lowering of the boats should not be performed from the ship. The launching system should be such that the boats can be conveyed from the ship to the water by the boat crew.

6. As it is of the greatest importance to minimize the labor involved in getting the boats from their stowed position into the water, the releasing appliance must be as simple as possible and boat cradles should preferably be avoided. Also boats in their stowed position should be connected with the conveying apparatus, so that they can be launched at a moment's notice.

The Peterson launching apparatus has been constructed to meet these severe requirements and care has been taken to make it with as few parts as possible.

The new system comprises two permanent overhead tracks, each having a terminus on both sides of the vessel, and four booms of built up section forming a continuation of the tracks, when swung in position ready for use. The number of boats to be stowed




DECK PLAN OF SHIP WITH PETERSON BOAT LAUNCHING APPARATUS.

Following are the most important requirements for an efficient boat launching device:

1. The apparatus must be so constructed that it can be worked by manual power with great ease. To depend upon steam or other artificial power is objectionable, as this may not be available when most needed.

2. Boats should be so located that passengers and crew can easily get into them. Stowing of boats inside each other or bottom-up, as is sometimes the case, is absolutely condemnable.

on each track has to be determined by the total number carried, but it is not advisable that more than four boats should be carried on one track. In the stowed position the boats are suspended from the tracks, and kept in equilibrium by rope lashings through the keel and eyebolts on deck. Trip hooks can be used but rope lashing is safer, as a knife, which is always handy, will release the boat in less time than a trip hook.

The permanent tracks are made of two Z bars riveted to the overhead structure. The lower flanges

of these Z bars form a guide for truck C, the conveying medium for the boats. To this truck the boats are connected by two stout hemp ropes of sufficient strength passing over sheaves which are mounted on the same pin as the rollers. One end of the hemp ropes is attached to a hanger *i*, embracing the boat and thus giving four points of support, instead of two as used in the present system, and adding to the stability. The other part of the ropes passes over a leader near the center of the boat, to a friction brake at the stern, which holds this end of the rope firmly, and when boats are to be lowered this is done by operating a lever which releases the grip on the ropes.

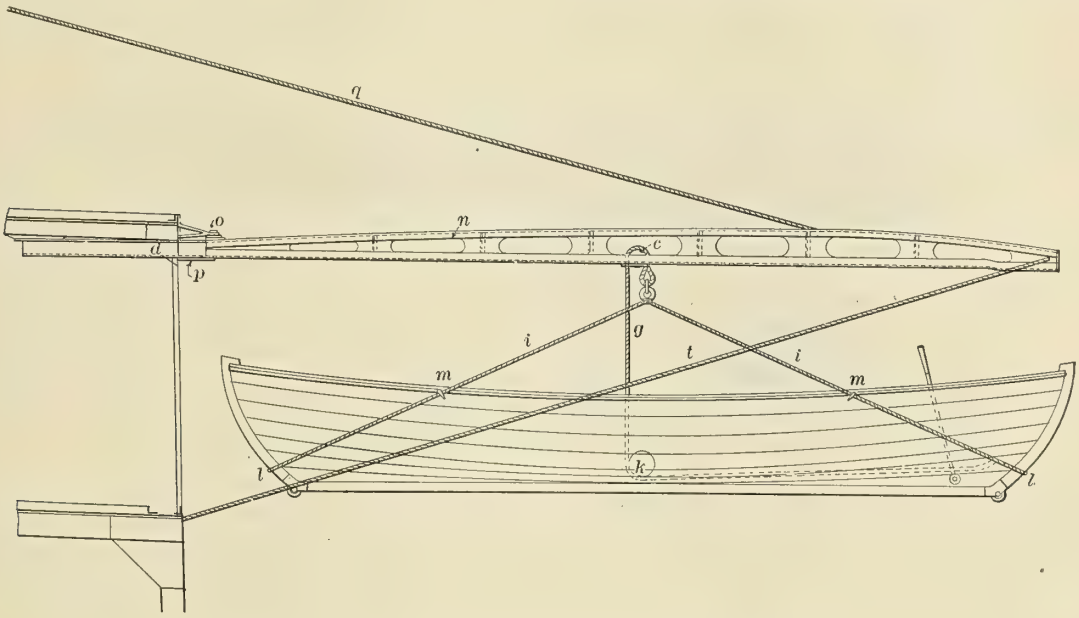
The second part of the launching apparatus, the booms, are pivoted at the terminus of the track and carried partly by straps *p* on the permanent track, and partly by the stay or stays, *q*.

over the sheave and drops into the water leaving the trucks on the boom. A recess on the outer end of the boom—which is closed—prevents the truck from rolling back. When the boat reaches the water the weight is taken off the hanger, and as this is simply laid in slots cut in the stem and stern, and guided by open eyebolts *m*, it can be easily removed.

For further information upon this subject address Mr. C. F. Peterson, 2210 Washington St., Wilmington, Del.

### Duplex Centrifugal Separator.

As it is often inconvenient to place a steam separator in the line of the main or branch steam pipes leading to the engines, the Standard Centrifugal Separator manufactured by Joseph De Rycke & Co., New York City, has been modified as shown in the illustration,




BOAT SLING AND BOOM OF NEW APPARATUS FOR LAUNCHING BOATS.

Spans and guys, *u* and *t*, serve to keep the booms in position. When not in use these are folded up against the ship's side. To put the booms in position ready for launching, and releasing the boats by cutting the lashing ropes, will not require as much time as accommodating the passengers in the boats. When this latter part is done the boats are pushed along on the racks and out to the end of the booms, from whence they are lowered from the boat itself by the use of above mentioned friction brake, controlled by one of the crew detailed for this duty.

The booms and stays are designed to safely carry the weight and are made long enough to allow the boats to clear the ship's side.

By this system the boats can be launched from either side of the vessel as the tracks extend across from side to side. For the safe conveyance of the boats over the deck, rollers are applied at the junction of the keel and stem or stern. When the boats are lowered the free end of the lowering rope passes

so that it can be placed in the interior of boilers or their steam drums.

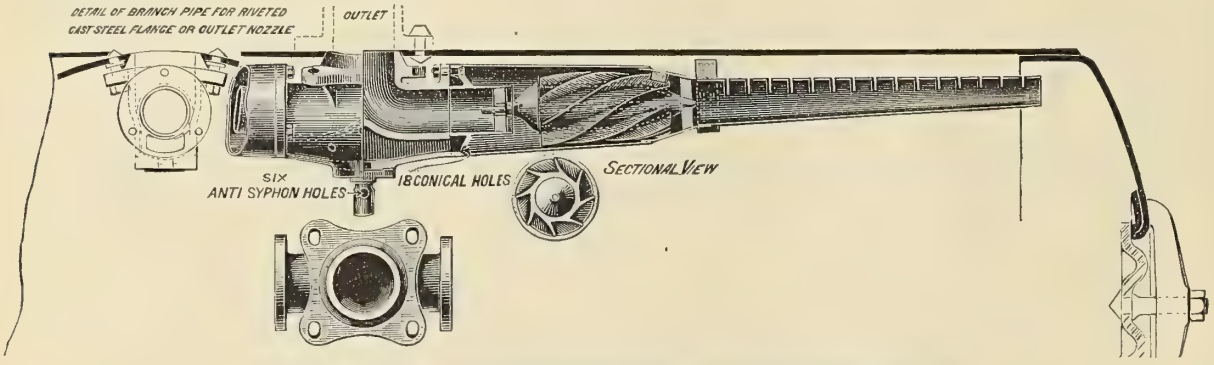
Steam is admitted in the Duplex Separator through two dry pipes which are open at their ends and have slits extending along their entire upper surfaces. By thus drawing the steam from an extended surface a uniform distribution is secured, thereby greatly reducing the tendency to lift the water. The combined area of the openings in the two dry pipes is equal to twice the area of the main outlet.

The steam then enters the centrifugal separators, one at the inner end of each dry pipe. The separator consists of a shell or casing in which there is firmly secured a stationary double ended cone on which are cast a number of knife edged wings extending spirally along its exterior. When the steam strikes this separator it is spread over the cone and given a whirling motion by the wings, causing the heavier particles of entrained water to be thrown outward by centrifugal force, and whirled along the shell into a separate chamber which

is entirely isolated from the flow of dry steam. Separation is further assured by subdividing the steam into a number of channels whereby every particle of the entire volume is acted upon. After separation takes place, the steam from both separators unites and passes out through a central pipe to the main outlet, while the water returns from its chamber to the boiler through the discharge pipe. In water tube boilers this pipe extends below the water line and is perforated to prevent the possibility of syphonic action.

By placing separators within a boiler, or steam drum, the entrained water is returned to the boilers without any loss of heat, an advantage which will be appreciated by marine engineers. These separators are secured to the central outlet box with composition studs and nuts, and the parts are so constructed and of such size as to be easily passed through an ordinary manhole.

Further details may be had by addressing the manufacturers, Joseph De Rycke & Company, New York.


DETAIL OF BRANCH PIPE FOR RIVETED CAST STEEL FLANGE OR OUTLET NOZZLE
OUTLET
SIX ANTI SYPHON HOLES
18 CONICAL HOLES
SECTIONAL VIEW

DE RYCKE DUPLEX CENTRIFUGAL SEPARATOR PLACED WITHIN A BOILER.

### Standardization of Extra Heavy Flanges.

Steam pressures varying from 100 to 250 pounds pressure entered into engineering practice about the year 1889. For pressures less than 100 pounds there had long existed confusion regarding standards for flanges of pipe, fittings and valves. A Schedule of Standard Flanges was adopted July 18, 1894, by a committee of the Master Steam and Hot Water Fitters' Association, a committee of the American Society of Mechanical Engineers, and the representatives of the leading valve and fitting manufacturers of the United States. As the use of high steam pressures became more general there came into existence so many different diameters, thicknesses, drilling circles and number of bolts for flanges on fittings, valves and pipe for extra heavy pressures that manufacturers could not safely keep stocks of goods, and mill architects and engineers were greatly delayed at times in making up specifications for contemplated work on account of the time taken to find out what the different manufacturers could or would furnish.

Recognizing the need of a standard for extra heavy fittings Mr. J. C. Meloon, Mechanical Superintendent of the General Fire Extinguisher Co., Providence, R. I., issued an invitation to the leading valve and fittings concerns of the country to meet and consider this subject. In response to this invitation several of the largest concerns sent representatives to a meeting at New York city, April 24, 1901. At that meeting a committee of prominent manufacturers was chosen to formulate a standard. The committee held various sessions and submitted to the manufacturers interested the following recommendations and Schedule for Standard, at a meeting held in New York city June 28, 1901:

Paragraph 1. Multiples of four for drilling.

Paragraph 2. Drilling should straddle vertical axis.

Paragraph 3. Bolt centers not to exceed 3 5-8 inches except on 2 1-2 inch size. Committee at first proposed 8 5-8 inch bolts for this size, but sample elbows and flanges were drilled and bolted together and it was found that 8 5-8 inch bolts interfered with inserting them in place.

Paragraph 4. Distance from center of bolt to edge of the flange should always equal or exceed the diameter of bolt plus 1-8 inch for 9 inch valves and under, and diameter of bolt plus not less than 1-4 inch for sizes larger.

Paragraph 5.

| Size of pipe, inches. | Diam. of flange, inches. | Thickness of flange, inches. | Diam. of bolt circle, inches. | Number of bolts. | Size of bolts, inches. |
|---|---|---|---|---|---|
| 2 | 6½ | ⅞ | 5 | 4 | ⅝ |
| 2½ | 7½ | 1 | 5⅞ | 4 | ¾ |
| 3 | 8¼ | 1⅛ | 6⅝ | 8 | ⅝ |
| 3½ | 9 | 1 3-16 | 7¼ | 8 | ⅝ |
| 4 | 10 | 1¼ | 7⅞ | 8 | ¾ |
| 4½ | 10½ | 1 5-16 | 8½ | 8 | ¾ |
| 5 | 11 | 1⅜ | 9¼ | 8 | ¾ |
| 6 | 12½ | 1 7-16 | 10⅝ | 12 | ¾ |
| 7 | 14 | 1½ | 11⅞ | 12 | ⅞ |
| 8 | 15 | 1⅝ | 13 | 12 | ⅞ |
| 9 | 16 | 1¾ | 14 | 12 | ⅞ |
| 10 | 17½ | 1⅞ | 15¼ | 16 | ⅞ |
| 12 | 20 | 2 | 17¾ | 16 | ⅞ |
| 14 | 22½ | 2⅛ | 20 | 20 | ⅞ |
| 15 | 23½ | 2 3-16 | 21 | 20 | 1 |
| 16 | 25 | 2¼ | 22½ | 20 | 1 |
| 18 | 27 | 2⅜ | 24½ | 24 | 1 |
| 20 | 29½ | 2½ | 26¾ | 24 | 1⅛ |
| 22 | 31½ | 2⅝ | 28¾ | 28 | 1⅛ |
| 24 | 34 | 2¾ | 31¼ | 28 | 1⅓ |

Paragraph 6. The bolt circle diameters as above stated will allow the use of calking recess on pipe flanges provided such device is specified.

The schedule presented was unanimously adopted by the manufacturers present, and January 1st, 1902, was the date set for adoption of same. Many leading firms have already agreed to adopt the standard and put same into effect on this date.

A limited number of the schedules will be printed by the committee and copies can be obtained of the Secretary, Mr. J. F. O'Brien, P. O. Drawer No. 66, Station A., Hartford, Conn.

## THE PROFESSOR ON SHIPBOARD.

### Story of an Attempt to Combine Theory With Practice.

BY C. A. MC ALLISTER, FIRST ASSISTANT ENGINEER, R.C S.

### CHAPTER III.

The following morning the Professor got up just before breakfast time, but he was not feeling quite as well as usual. The fact of the matter was that his experience of the previous day had tired him out. After breakfasting he made up his mind to rest all day on deck and if he felt any better he thought he would try a night watch in the fireroom, as he had determined to spend some further time around the boilers.

Having brought some books with him, he managed to while away the morning hours very well by sitting on a steamer chair in the shade of an awning and reading. In the afternoon he took a short nap in a hammock, and afterwards spent several hours very pleasantly talking with some of the passengers. During his conversation he fell to discussing the running of steamships in a general way, and was greatly surprised to learn how little the average sea traveler knows of how ships are run. The majority of them seemed to look upon the engineer's force as a kind of necessary evil, and were very prone to give the entire credit for the safety of the vessel, etc., to the well dressed deck officers who after standing a watch on the bridge, spent their spare time in gossiping around among the passengers. The Professor proceeded to enlighten them upon the vast responsibilities heaped upon the workers in the engine and fire rooms.

"Why," said he, "if you could but realize it, your very lives are constantly at the mercy of those men down below there. Suppose that one of the water tenders should be negligent of his duties and allow the water to get below the danger point in the boilers. Well! you would never be able to collect the pieces."

He likened the four boilers to a magazine containing a large quantity of dynamite—perfectly harmless so long as they are taken care of, but if they ever explode, it is all over with the ship. Continuing, he said:

"You who travel by steamer may never know how much your safety depends upon those grimy looking individuals whom you see crawling out of the fireroom hatch, but at the end of this voyage if you have any praises or thanks to offer for a safe journey, remember that a large portion of it is due those suffering men below, where you passengers never visit."

Towards evening the first heavy clouds of the trip were seen away on the horizon. The first officer remarked that the barometer had been falling and that they would probably encounter some dirty weather before morning. This was not particularly cheerful news to the Professor, and he turned in shortly after sundown resolving to spend the mid watch below.

He had seemingly been asleep only about an hour when a sharp rapping came at the door of his stateroom, and a harsh voice announcing that it was a quarter to twelve, was heard on the outside. As the college man gradually opened his eyes and regained his consciousness it dawned upon him that something unusual was occurring. His watch which he had hung on a hook was swinging from side to side; his shoes were having a hurdle race to and fro on the floor, and as he attempted to rise an unusually severe lurch of the vessel rolled him out of his bunk on the floor, and as he attempted to rise, an unusually severe wind through the rigging could be heard and the mournful sounds thus produced struck terror to the Professor's heart. His first impulse was to crawl back into his bunk, but he finally made up his mind to see it through and make the best of it.

After a great deal of difficulty he succeeded in getting into his clothes, and half struggling along he groped his way to the engine room. Standing on the upper engine room grating and grasping a hand rail he gradually came to the realization of what was before him. To add to his discomfort he began to feel the first qualms of sea sickness. He again almost decided to retrace his steps, but just at that moment the second assistant engineer came up and in a cheery voice said: "Good morning, Professor. Now you will have a chance to see how we run things during a gale of wind." It was too late then to go back, and with a forced smile he said: "I don't see how you manage to stand on your feet, let alone do any work." The fact that the second assistant was vigorously puffing away on a large black pipe and blowing the smoke towards the Professor did not add the least to his comfort. By a strong effort of the will, however, he made a dash over to the engine room ladder and slowly began to descend the steps. One moment he felt like a fly walking on a ceiling and the next he seemed to be walking on a horizontal ladder, but he managed to hold on until within about four steps of the floor plates in the lower engine room. At this juncture his feet slipped off the oily steps and losing his grip on the hand rail he fell sprawling on the floor. An oiler seeing his plight ran over to him and assisted him to get on his feet again, remarking at the same time, "I hope you are not hurt, sir." Upon regaining his breath he replied that he was more scared than hurt. Feeling somewhat rattled by his hasty descent, he managed to crawl over to a seat where, by locking his arms around a convenient stanchion he was able to keep his position. The fearful rolls and plunges of the vessel were not felt so badly in the lower engine room, but, nevertheless, walking about was accomplished only by taking advantage of the brief intervals when the ship was on an even keel and then hanging on to some convenient stanchion, pipe or other fixture. The oiler, who had spent many a weary watch under just such conditions, went about his work, now feeling a crank pin with one hand while holding on with the other, and again vigorously working a squirt can into some cup or oil hole. Apparently he cared nothing about how badly the ship was lurching. Such nonchalance filled the Professor with amazement, and he wondered how many trips he would have to make before he could get about with such apparent ease. With the intention of making his engine room observations on some other day he reluctantly left his safe perch and half walking and half crawling made his way to the fireroom. Just as he stepped in, greatly to his horror, he found he was standing in water half way up to his knees.

As the vessel rolled over to the other side there was the sound of rushing water, and he noticed that the opposite side of the fire room floor was inundated. Visions of a sinking ship flashed across his mind, and he mentally calculated how long it would take for the water to reach and extinguish the fires. Noticing that the men did not seem at all excited, he made his way over to one of them and in a trembling voice inquired if the ship was sinking. "Oh, no, sir; don't be afraid—there is nothing the matter except that the strainer on the end of the suction pipe is plugged up. Callahan is cleaning it out now, and we will soon have this water out of her." Looking down between the after boilers he saw a big brawny fireman standing in water up to his waist, and as opportunity offered reaching down and pulling up handfuls of coal, ashes, and occasionally small lumps of waste. After a great deal of effort the strainer, one of the ordinary box variety, was cleared out, and before long the welcome sound of sucking mixed air and water was heard at the strainer, thus indicating that the bilges were free. Cleaning out the strainer under such conditions seemed to the Professor as little less than barbarous, and he wondered why designers did not fit all suction pipes with Macomb strainers placed above the floor plates where they would be easy of access for cleaning out.

Placing himself in an out of the way corner, where he had a good place to hang on, he decided to remain there and look about. His attention was naturally attracted to the gauge glasses, and he hoped that none of them would blow out again while he was in the fire room. The way the water was dancing up and down somewhat startled him. One instant the glass would be filled over the top and the next it would go out of sight at the bottom. Each glass was on the inboard side of its boiler, and naturally the fluctuation of the water level was very great at each roll. This arrangement seemed to the Professor rather uncalled for, as he could see no objection to having the glass right opposite the center of each boiler, where the water would naturally be quieter than on either side. Remembering his conversation with the water tender on the previous day, he concluded that if the men could not be made to use the gauge cocks, an ideal arrangement would be to have two separate gauge glasses, each with independent pipe connections, and both arranged at the center of the boiler in such manner, of course, that they would be clear of the connection door.

He observed with some satisfaction that the firemen were following his advice in not charging more than one furnace at a time. He was, however, surprised to see that it took one man to hold a door open while another one was shoveling in the coal. He didn't think it possible that any man would get up furnace fittings in these days without having catches fitted to hold the doors open when firing in a heavy seaway.

His attention was next attracted to the steam gauges, as no two of them showed the same pressure. The after port boiler gauge registered 155 pounds, while its mate showed only 150 pounds pressure. He asked the water tender if the gauges had ever been tested and was informed that they had not been tested since he joined the vessel. He further remarked that he had some fun with a green fireman on a previous trip. The greenhorn had the boiler with the low gauge on it, and he nearly worked himself to death trying to get his steam up to the pressure shown on the opposite gauge. The Professor remarked that he thought that every ship should have a standard test gauge on board, and that all gauges should be regulated at least once in three months. In this connection he said that all springs were unreliable, and that the only proper gauge tester would be one that used actual weights for the purpose of comparison. Noticing that the water tender when manipulating the feed checks had to go around to the sides of the boilers, he asked him if he did not think it was rather inconvenient. The water tender said it would be much better to have them on the fronts of the boilers, and said that he wished the draughtsman who had arranged these checks could be there and have to tend water himself. He also suggested to the Professor that it would be better to have the main check on one side of the front and the auxiliary check on the other side, as it would save confusion when breaking in a new man. While on this subject he called the Professor's attention to the temperature of the feed water. Upon investigation he found that he could easily bear his hand on the check valves. The Professor remarked that he did not believe the feed water was entering the boiler at a temperature of more than 130 degrees. "There is one of the results of it," he said, pointing to a spot on the seam of the lower head which was covered with salt and bubbling. "The other result will be found in the coal bill. I wonder how long it will be before ship owners will realize that feed water heaters will pay for themselves in six months' time. By the way," he said, "I notice that you don't tally up the coal you use." "Oh! that is too much bother," said the water tender.

"It wouldn't be much bother," said the Professor, "if you had a counter near the desk in the engine room and make the coal passers register each bucket of coal they dump in the fireroom, by simply pulling a wire connection each time. You could then keep an accurate account of the amount of coal you are using."

"Where are your bottom blow valves located," next inquired the visitor. In answer to this the water tender tapped his foot on the floor plates, indicating thereby that they were underneath the floor. "That is an old fashioned idea," remarked the Professor "It seems to me that they would be much more convenient if they were brought up on the side where they can be gotten at without raising a floor plate. They can just as well be bolted to the shell higher up and be connected to an internal pipe leading down to the lowest part of the boiler."

Continuing his questioning, he asked if there was any gear for raising the safety valves in case of necessity. He was shown a screw gearing secured to the bulkheads at the sides in an almost inaccessible place. The threads of the screws were rusty in appearance and looked as if they had never been used since they were put in place. He said to the water tender, "You ought to keep that gearing well oiled and ready for

use—some day you will want to get at it in a hurry and you will find that you can't turn that hand wheel with a yoke of oxen."

The Professor by this time thought that he must have been in the fire room for at least four hours, but was disappointed upon consulting his time piece to find that it was only half past one. He began to feel very weak in his stomach, as the rolling had increased considerably since he came below. He began to wish he was on shore where he could walk without using his hands as much as his feet. In fact he was beginning to realize keenly some of the discomforts of a seafaring life. No one who has not had the actual experience can realize what it is to be called at midnight from a sound sleep, get up and dress and go into a hot engine or fire room and at once, before being quite awake, assume the responsibilities of keeping things moving, no matter how hard a gale is blowing or how rough the sea. The time from midnight until 4 A. M. under such circumstances drags along until one feels that a month must have passed before his relief appears. The Professor on this occasion did not wait until the watch was over, but had enough of mid watches by 2 A. M. and managed to get his clothes off and crawl into his bunk, where he spent the remainder of the night trying to keep from rolling out on the floor, and in retaining his dinner of the previous evening.

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**Boilers on Lake Vessels.**—For two or three years past many of the large carriers on the Great Lakes have been equipped with water tube boilers. This year the new vessels have been installing Scotch boilers, and, in many cases, forced draft has been adopted.

### A Nest of Torpedo Boats.

The accompanying picture was taken at Sunderland when the torpedo-boat destroyers of the Chatham Instructional Flotilla visited that port. At first glance, judging from the numbers of stacks and ventilators, it would appear that there are many more than the actual number, which is eight, including the one whose life-boat is shown at the lower left hand corner. They comprise the *Mallard*, *Cynthia*, *Lee*, *Snapper*, *Porcupine*, *Bittern*, *Desperate* and *Mermaid*.

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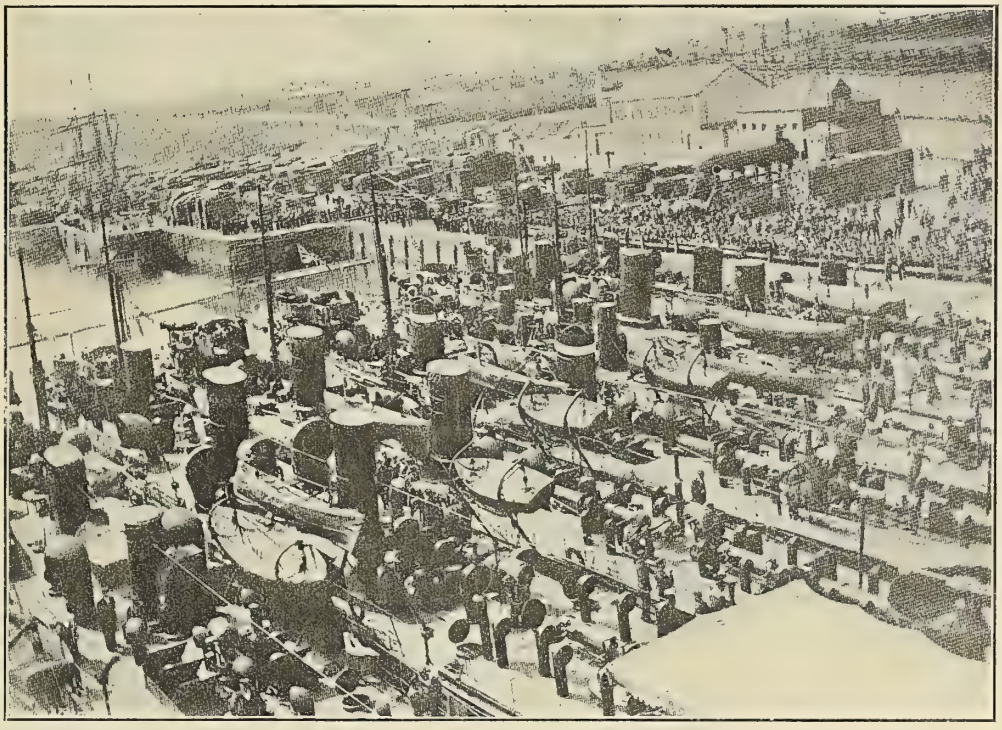
### Shallow Draft Gunboats.

Two shallow draft gunboats, the *Teal* and *Moorhen*, have been built by Yarrow & Co., to the order of the British Admiralty for service in African and Chinese waters. The *Teal* recently completed her trials most satisfactorily, and is the first vessel to attain a speed of 13 knots on a draft of 2 feet 3 inches, without the use of forced draft.

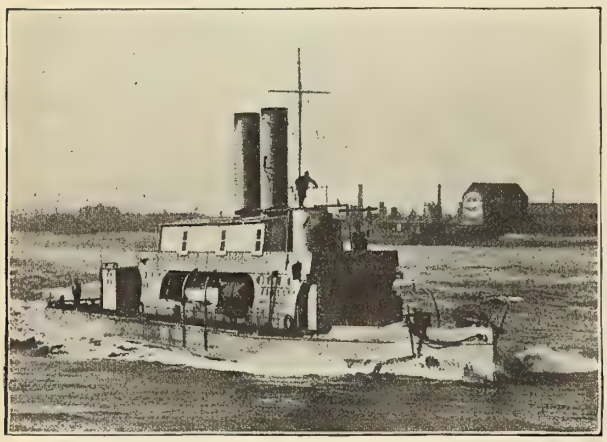


BRITISH TORPEDO BOAT DESTROYERS AT SUNDERLAND, ENGLAND.

There are several interesting features of construction about these boats. The hull is built entirely of galvanized steel and is subdivided into ten water-tight compartments, each compartment being floatable and independent of the others. This floatable section system of construction has been used for many years by Yarrow & Co., for small knock-down orders, as it allows the vessels to be put together while afloat. The twin screws, about 4 feet 6 inches in diameter and with three blades, revolve in tunnels constructed in the boat parallel to the keel. These tunnels begin well forward, and rise gradually to a point where the propellers are placed about 15 feet from the stern and then curve downward, terminating in a spoon-shaped plate just be-

low the water line. A vacuum of 8 inches is maintained at the crown of the tunnel, so that the tunnel is always filled with water. In this system very shallow draft is secured, and the propellers are easily inspected by lifting the doors placed at the highest part of the tunnel, which part is above water line.

The vessels are 150 feet long and 24 feet 6 inches wide. The main deck is of steel, covered with corticine. The upper or battery deck is supported by forward and after superstructures, and has airy accommodations for the crew. The sides of the vessel, in way of machinery, the superstructures and the bulwarks on the battery deck are of chrome steel and bullet proof at close quarters. A steel conning tower is placed forward, and is also bullet proof. In the forward superstructure is a cabin divided for three officers and a commander, and aft of this is a cabin for eight petty officers. The bullet proof sides are loopholed for rifle fire. Ammunition is stored in magazines below the main deck, and is conveyed to the battery deck through hoists within the superstructure.



SHALLOW DRAFT GUNBOAT TEAL.

The machinery consists of two compound surface condensing engines supplied with steam from two Yarrow water tube boilers, designed to give full power when burning wood. Forced draft is provided in case of emergency, but was not used on the trial.

To insure quick manoeuvering, so necessary in navigating crooked rivers, four rudders are placed at the square stern, and can be operated either by hand or steam.

The mean average of six runs over the measured nautical mile on the Thames, during the official trial of the *Teal*, resulted as follows:—

| | |
|---|---|
| Draft | 2 ft., 2½ in. |
| Boiler pressure | 150 lbs. |
| Vacuum | 26 in. |
| Revolutions per minute | 282.9 |
| Mean speed | 13.045 knots. |
| Trial Loads | 40 tons. |

The remarkable performance of this vessel, so completely equipped with all the requirements of service, is of interest not only to the naval engineer, but also to the merchant who is interested in the development of trade along our shallow rivers at home or abroad.

The above illustration is reproduced from *Engineering*.

## QUERIES AND ANSWERS.

Q.—How can I reverse the direction of rotation of a motor armature? F. J. S.

A.—The direction of rotation of a motor armature can be reversed by taking out the wires connecting with the brushes and reversing them. When this change is made the brushes are likely to spark considerably, owing to the fact that they will be set in advance of the neutral line—that is, they will be nearer the forward pole than the back one. To stop the sparking, set the brushes backward until the best position is found by actual trial. If the brushes are metallic, they will set at an incline to the commutator surface, and in that case the motor cannot be reversed unless the brushes are so constructed that they can also be reversed. Carbon brushes generally stand perpendicular to the commutator surface, or nearly so, and the armature can run in either direction equally well.

Q.—How is the resistance of wire ascertained? G. M. P.

A.—The resistance of wire is ascertained by actual measurement. There are several ways in which this can be done; the simplest consists in using what is commonly called a testing set, or bridge. This instrument is a combination of a galvanometer, and a set of standard resistance coils, and they are so connected that the resistance of the wire or other object is determined by direct comparison in the same way as sugar is weighed on a grocer's scales. The standard coils are connected in one of two parallel circuits, and the wire to be tested is connected in the other circuit. The number of standard coils is then increased or decreased until a balance is obtained, and then the resistance of the wire is known, as it is either equal to that of the coils in the circuit or is ten or one hundred times greater or smaller, according to whether the instrument is set for a direct comparison or not. There is an instrument on the market known as a direct reading ohm meter which gives the resistance directly by simply moving a contact point along a wire until the balance point is found.

Q.—Can two generators of the same voltage but different amperes be run together in parallel? D. T. R.

A.—The difference in the amperage of two generators will not interfere with their running together in parallel. If both machines are so proportioned that they vary the e. m. f. in like proportion for variations in current strength, they will run together well at all loads, otherwise they will not. If the machines are simple shunt wound, and the speed is fixed, all that can be done is to adjust the field rheostats so that the load will be divided equally when it is at the average working magnitude. Then, for any variation in the load, one machine will take more than its share and the other one less, and the greater the variation in the load from the average the greater the difference in the amount carried by each machine. If the generators are compound wound, they can be made to vary the voltage in corresponding amounts for given variations in current by removing a few turns of wire in the series coils of one machine. For example, suppose that two such generators are adjusted so as to divide the load equally when the current is 100 amperes, and that when it is reduced to 25 amperes one delivers 15 and the other 10 amperes. Then if a few turns of the series coils of the machine that delivers the strong current are removed its voltage will be correspondingly reduced, and likewise the current. If now the current is again increased, this machine will not carry its share of the load at 100 amperes, but it can be made to do so by adjusting its field rheostat. By continuing this process of adjustment the two machines can be made to divide the load in the proper proportion, whether the current is weak or strong, and this is true regardless of whether the machines are equal or unequal in size.

Q.—What would be the result if a compound wound generator were short circuited when running at full load? What would be the effect with a shunt wound machine? M. H. D.

A.—The effect of short circuiting a compound wound generator would be to increase the current strength to such an extent as to stall the engine unless its power were far greater than that required to run the machine. If the generator were belted, and the belt were not tight or well guided, it would probably run off the pulley. Assuming the power to be sufficient to keep the machine running at full speed or nearly up to that point, the increased current passing through the armature would greatly heat the wire and thus weaken the insulation and finally result in a burn-out. The foregoing would be the result with a thoroughly well-constructed generator. With a machine of inferior construction the probabilities are that the armature would be damaged even if the power were not much in excess of that required to run up to the full rated capacity. With a shunt wound machine the result would be similar, but not so severe; in fact, with a very small generator the short circuiting of the armature would probably result in cutting down the field current so far that the machine would fail to excite, and thus damage would be prevented.

Q. (1) Would it be possible to obtain an air pressure of 5 or 6 pounds above atmosphere by means of a centrifugal fan?

(2) What would the dimensions of such a fan be with engine running 500 revolutions and supplying 45 cubic feet of air per minute at above pressure?

(3) At 1,000 revolutions with same quantity and pressure?

(4.) If impossible to get this result with fan, what size and stroke of air pump would be needed?

"ENGINEER."

A. You cannot expect to obtain as high a pressure as 5 or 6 pounds with an ordinary centrifugal fan or blower. The pressures obtained by such means are usually measured in inches of water and vary under the usual conditions of marine practice from 1 to 5 or 6 inches; rarely more, even with torpedo boat boilers and similar types of practice. A pressure of 6 pounds or .4 of an atmosphere measured in inches of water would be about 160, so that this pressure is at least fifty times greater than the average usually employed for draft purposes.

To obtain a pressure of this amount either an ordinary type of piston air compressor may be employed, or a blower of the "positive" type. The size necessary may be found by referring the required volume back to atmospheric pressure. For a delivery of 45 cubic feet under 6 pounds pressure this would give $21 \times 45 \div 15 = 63$ cubic feet of air per minute at atmospheric pressure. To this a margin should be added for leaks, making the suitable capacity about 70 cubic feet per minute.

Q. If a piston rod should get hot would it be best to slow the engine or to stop her still? Would you take a chance of bending the rod if you stop her? Also, what is best to do if one of the furnaces comes down in a boiler while at sea? Let me know what to do if you had only one boiler; also if you had two boilers.

E. F. J.

A. It is impossible to answer in specific terms questions of this character. Too much depends on the especial circumstances of the case. Presumably, the best course to follow with a hot piston rod is to supply lubricant in excess and slow the engine, or, if necessary, stop her. There is no especial danger of bending the rod unless the conditions are very abnormal. The cause of a hot piston rod is presumably undue friction in the stuffing box, and this should receive immediate attention and the packing loosened if necessary.

If the furnace of a boiler comes down only slightly the boiler should be opened up and the plate cleaned on the water side. It may then be possible to use the boiler at a reduced pressure without further repair. Still better, if possible, a strong-back may be fitted on the water side with bolt passing through the metal of the furnace and set up with nut and copper washer under head on the fire side. This will support the metal and will serve satisfactorily as a temporary repair. Still better, the plate may be forced back in place by heating with an improvised furnace holding coke or charcoal, and then applying pressure by means of a screw or hydraulic jack. If possible a metal form approximating to the shape of the furnace should be used between the head of the jack and the metal of the furnace. By this means and with care the furnace can be restored to its original shape if the sag or pocket is not too serious in character.

With one boiler a repair of some kind is necessary. With two, if no repair can be readily made, the disabled boiler can be cut out and the remaining one used to make the remainder of the trip, or the best way to the nearest port.

Q. Please state in the next issue of your paper what determines the lead of an engine, also in regard to the lap of an engine. J. J. B.

A. By the "lead of an engine" you mean, of course, the lead of the valve. This is the width by which the port is open or uncovered when the engine is on the center. In amount it varies with the size of the engine and other circumstances, but is usually found between 1-8 and 1-2 inch. Where no especial considerations enter it may be taken from one-fourth to one-third of the full port opening.

Similarly, the lap of the valve is the amount by which it covers the port when it is in its mid position. This likewise varies with the size of the engine and with the point of cut-off desired, being wider with earlier, and narrower with later cut-off. In marine practice and with usual proportions the lap will be not far from the width of port opening.

Q.—Suppose on a long distance voyage rain water is caught and run into tanks and then used as supplementary feed, has it any bad effect on the shell and heating surfaces of a boiler, due care being taken to have a light scale on the heating surfaces. J. M.

A.—So far as we have heard rain water has no bad effect on the shell and heating surfaces of a boiler, especially if it is covered with a light protecting scale. The plan of catching and using rain water is, however, rarely resorted to, due to its unreliability, and the need of a more regular and reliable source of supply.

Q.—I notice that most if not all the dynamos and motors I have seen have from one-eighth to a quarter of an inch of end play in the shaft. What is the object of this? Why would they not run just as well without end play? R. C. A.

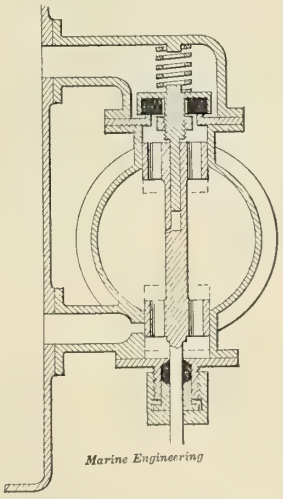
A.—The object of the end play in the armature shaft is to enable the commutator brushes to traverse the commutator surface and thus prevent the cutting of ruts. This end play also acts in the same way to keep the shaft bearings from cutting and forming grooves.

Q. Will you please work out the following example and oblige: The fresh water tank of a vessel measures 4 feet by 8 feet by 9 feet high. The water which filled the tank two-thirds full is discovered to be frozen, and it is desired to melt it by turning live steam at a pressure of 90 pounds absolute into the tank. What is the minimum weight of steam required to melt the ice, if the tank is at a temperature of 30 degrees Fahrenheit, and assuming that no heat is lost in the operation?

A. We readily find that the number of cubic feet of water is 192, and at 62.5 pounds per cubic foot this will make 12,000 pounds of water, or of ice. Now to raise a pound of ice one degree in temperature requires, in general, one-half a heat unit. Just below the freezing point, however, the amount is about one unit for each degree, or as much as for water. It will therefore require two heat units to raise a pound of ice from 30 degrees Fah. to the freezing point, 32 degrees. It will then require for the melting the so-called latent heat. This is 79.25 heat units per pound. The total amount of heat needed to raise one pound of the ice to the melting point and then melt it is therefore $79\ 25 + 2 = 81.25$. This multiplied by 12,000 gives 975,000 heat units as the total amount required from the steam. Now from steam tables it may be found that the total heat of one pound of steam from 32 degrees Fah., and at a pressure of 90 pounds absolute, is 1,179.6. This is therefore the amount of heat which one pound of steam can furnish by its condensation and cooling to 32 degrees. It will therefore require as many pounds of steam to melt the ice as this number is contained in 975,000. This is found to be 826.5 pounds.

## SELECTED MARINE PATENTS.

682,628. WATER-FEED FOR BOILERS. SAMUEL D. MOTT, PASSAIC, N. J., ASSIGNOR, BY MESNE ASSIGNMENTS, TO MOTOR-MOBILE COMPANY, JERSEY CITY, N. J.




*CLAIM.*—1. The combination with the receptacle having a water-inlet and boiler connections near the top and bottom of a pair of reciprocating valves adapted to open and close the steam connection and water inlet, and an independent valve adapted to close the steam connection, the said independent valve being moved up by the up-stroke of the first-mentioned valves.

682,631. VESSEL OR SHIP. PAUL MANCHIN AND LOUIS BOUDREAUX, PARIS, FRANCE.

*CLAIM.*—1. A vessel provided with a series of hermetically closable float chambers connected to the hull of the vessel, said chambers rising above the upper deck so as to form superstructures above the latter, the combined capacity of the float chambers and height of the same being such as to obtain a volume at least equal to the displacement of the volume of water necessary to float the vessel when the latter is completely immersed, and prevent the uppermost ends of the floats being submerged.

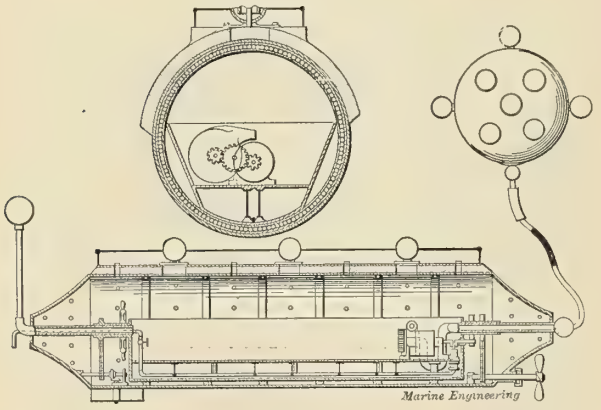
682,967. OAR LOCK. JAMES WHITE AND JOHN SNYDER, MARSHFIELD, ORE.

*CLAIM.*—1. In an oar lock the combination, with a yoke, of a stem thereto, a strip pivoted in the stem, an arm thereto projecting from the side of the stem near its upper end, a locking head to the strip, and means for holding said head normally projected from the side of the stem.

683,238. NIGHT LIGHT BUOY. CONRAD C. A. E. WIESE, HANBURG, GERMANY.

*CLAIM.*—1. A life buoy composed of a float, a carbid receptacle having a water inlet, and expansible bulb communicating with the carbid receptacle, a lever actuated thereby and adapted to close an electric circuit, a platinum igniting wire in circuit, a burner, a lead wire in proximity to the burner, and also in circuit, substantially as specified.

683,260. LIFE-BOAT. JOHN E. DYSART, CADIZ, OHIO.




*CLAIM.*—1. In combination with a boat, a valved float, a flexible tube connecting the float with the boat and having a ball and socket connection with each.

2. Means for supplying air to the boat, the same consisting of a float studded with automatically actuated valves, each communicating with the interior thereof, substantially as set forth.

5. Means for supplying air to a boat consisting of inner and outer concentric shells adapted to move freely one upon the other, automatic valves applied to the outer shell, and caster bearings between the two shells, consisting of oppositely disposed cups having antifriction bearings between matching parts, and provided with caster wheels, substantially as set forth.

683,490. SUBMARINE BOAT. JOHN P. HOLLAND, NEWARK, N. J., ASSIGNOR, TO ELECTRIC BOAT COMPANY, OF NEW JERSEY.

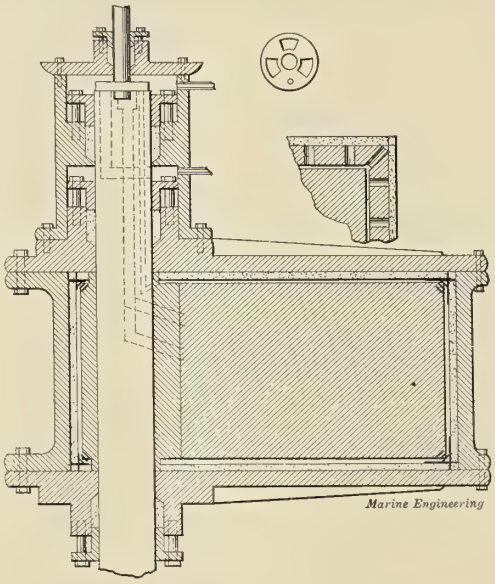
*CLAIM.*—1. The combination with a submarine boat provided with an expulsion tube, of a tank or receptacle connected with said tube, and capable of holding a volume of water sufficient to completely fill the expulsion tube when the latter contains a torpedo.

683,427. FLUID-PRESSURE STEERING-GEAR. LUCAS BARGER, NEW YORK, N. Y.

*CLAIM.*—1. A steering engine, the combination of a cylinder with a piston attached to the main shaft, on the end of which is formed a valve, and a primary valve seated on the said shaft for controlling the movement of the piston, substantially as specified.

2. The combination of a main shaft provided with ports; and a primary valve provided with an operating stem, with an exhaust channel and with an open chamber through said primary valve, which primary valve is seated upon the end of the said shaft to control the motor fluid to and from the cylinder, substantially as specified.

3. The combination with a main shaft adapted to be attached to a rudder shaft; a piston attached to the main shaft of an operating valve; means con[illegible]er[illegible]ng valve for applying fluid pressure to the opposite sides of said piston, said operating valve consisting of a main primary valve and an auxiliary secondary valve adapted, when in their normal relative position, to close the valve ports; the auxiliary valve keyed to the operating piston to secure automatic, co-extensive movement




thereof; means for manually operating the primary valve, substantially as specified.

683,540. OAR-LOCK. WILLIAM C. WILSON, PHILADELPHIA, PA.

683,703. INDICATOR AND RECORDER FOR THE PITCH OR ROLL OF VESSELS. WILLIAM F. C. NINDEMANN, NEW YORK, N. Y.

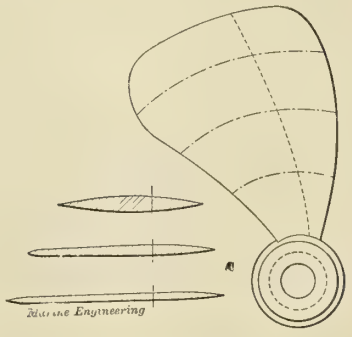
683,776. PADDLE-WHEEL. HENRY S. KLINE, McKEESPORT, PA.

*CLAIM.*—1. A paddle wheel, comprising end frames, blades supported by and mounted to swing between said end frames, a fixed casing at the outer side of one of said frames, deflecting devices, each consisting of two pivotally connected sections mounted to move into and out of openings at the opposite sides of said casing, means carried by the wheel shaft for causing said movements of the shifting devices, and cranks carried by the shafts for engaging with said deflecting devices, substantially as specified.

683,788. INDICATOR FOR THE PITCH AND ROLL OF VESSELS. WILLIAM F. C. NINDEMANN, NEW YORK, N. Y.

*CLAIM.*—1. An indicator for the pitch and roll of a vessel, comprising a bracket to be mounted in the vessel and having two projecting arms, a dial and its casing pivotally mounted at top and bottom in the arms of said bracket, so that its pivotal axis may be vertical when the vessel is on an even keel, an arbor in said casing, the hand thereon adapted to traverse graduations on the dial, a receptacle for liquid in said casing, and the pendulum fixed to the arbor and suspended in said receptacle, substantially as set forth.

683,808. SCREW-PROPELLER BLADE. SOMMERS N. SMITH, PHILADELPHIA, PA.




*CLAIM.*—1. A propeller blade of symmetrical cross section and having the greatest thickness of blade section between the helical center of the blade and the leading edge of the same.